RIPPLES IN WATER

REFLECTIONS FROM KEYSTONE'S WORK ON WATER IN THE NILGIRI BIOSPHERE RESERVE: 1995 - 2019

T. BALACHANDER

KEYSTONE FOUNDATION

CONTENTS

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List of Tables

List of Figures

Foreword

Keystone Foundation – a journey of 26 years. If I had to say three key words to capture this adventure, they would be honey, springs and people. Springs, wetlands and water sources in these mountains have continued to fascinate us like honey on cliffs and people's insights and living paradigm. Bala, I and our team – Gokul and others (Anita, Aradu Kuttan, Archana, Babu, Eswar, Eswaran (Entomologist), Justin, Kannan, Kunal, L. Rajendran, Leo, Manju, Mathew, N. Rajendran, P. Chandran, Priya, Rev Mulley, Samita, Samraj, Sarasasmeeta, Selvi, Senthil, Shanmitha, Shiny, Sivaraj, Sneh, Suganthi, Sumin and Thanvish) have worked from the first implementation in Kilcoupe, the survey of hill water and livelihoods in 65 villages of the Nilgiris, the stakeholders' workshop in Ooty to returning to the Sigur region for implementation. All this back and forth – from the large picture to the settlement, from ridge to valley, watershed to springshed – has built practice, research, action, policy briefs, narratives and a curriculum for interns and students. This book is the culmination of that process which started in 1995.

The work with the HCL Grant in 2018 has made us dive much deeper into the complexities of hill waters and their use and sharing with communities and wildlife. The implementation and practical demonstration of organic agriculture is another area of priority.

This book is meant for government departments at district, state and centre, donors who work with water and are keen to understand resource-rich areas which act as origins of water basins, students, interns, professionals and researchers.

We are indebted to many agencies and individuals who have supported us on this journey including The Swallows, Department for International Development (DfID), Winrock International India, International Union for Conservation of Nature (IUCN), Critical Ecosystem Partnership Fund, Taru Leading Edge, Sálim Ali Centre for Ornithology and Natural History (SACON), Cornell University, Arghyam, Advanced Center for Water Resources Development and Management (ACWADAM), India Natural Resource Economics and Management Foundation, Springs Initiative, Google Earth Outreach, the state government of Tamil Nadu, the district administration in the Nilgiris, the municipality of Coonoor and town and village panchayats.

Pratim Roy

November 2019

Preface

Water constantly touches all life on earth. It is a part of our stories, songs, art, culture, religion etc. We engage with it in myriad ways. It was always taken for granted as a plentiful resource in the Nilgiris, but today there is an overwhelming sense of a crisis associated with it. We are now in an era where water is first and foremost a precious resource that needs to be conserved. All of us need to rethink the way we relate different aspects of our lives to this life-giving gift of nature.

In this book we share Keystone's experiences in engaging with water resources in partnership with local communities over the last 25 years. We hope that this book will be useful to all those, within the Nilgiri Biosphere Reserve (NBR) and beyond, who want to reflect on their relationship with water. There are some sections that are necessarily technical in nature. We have tried to make these accessible to a lay audience. Case studies provide a context that local readers would recognise and understand and also material for students and researchers. Civil society organisations would readily identify with the content as the experiences are from projects implemented by an NGO.

This book is also intended to serve as a repository of organisational memory within Keystone so that future interventions can learn from and build on the efforts of the past. To that end it brings together material from a variety of sources such as project reports, case studies etc. The book is divided into sections for easy accessibility. Readers may identify parts that interest them and go through those in any order. This book and related content is hosted on the Nilgiris Water Portal maintained by Keystone Foundation at https://nilgiriswaterportal.in.

I would like to thank all the village communities in the NBR who have partnered with Keystone Foundation over the years. This book is based on the solid foundation of work that resulted from this partnership and continues to this day.

Thanks to Pratim for going through the early drafts and providing feedback. I would also like to thank advisors, colleagues, partners, community volunteers, interns and others who have contributed to this body of work. We are thankful to the donor partners who have supported Keystone's work on water. Thanks are due to Rajyashree Dutt for editorial support and Identiek Design Studio for layout and printing.

I am grateful to Archana, my wife, colleague and pillar of strength, and Vasudha and Vyoma, our children, for their patience, support and encouragement in the long process of producing this book.

T Balachander

November 2019

A stream in a forest

THE ORIGINS OF KEYSTONE'S WORK ON WATER

The very idea of Keystone was first discussed by the founders on the banks of a river! Thus, a dream, an idea, a vision was born, and the flowing waters bore witness to a historic moment. The work of Keystone over the next 26 years, across various thematic areas and geographies, could be likened to a river that finds its own path, at times meandering slowly and at others flowing swiftly. With the help of community members, well-wishers and friends, Keystone's unique set-up is often called an ecosystem of its own. The basic philosophy of Keystone, embodied by the concept of the 'Tree Fall Gap', is one of constant churning and renewal. This is very well reflected in Keystone's work on water over the years.

Keystone's work in the Nilgiris began with an exploration of honey-hunting and bee-keeping among the tribal communities near Kotagiri. This was but one strand in the web of life of the *adivasi* communities, which in turn led to the other interconnected strands such as livelihoods, land and water resources, health etc. With the appreciation of the precarious position of the *adivasis* living in forest settlements, came the realization of the need to work on some basic needs of the people. This included improving their access to water.

For instance, in Kilcoupe village the people used to periodically clean out holes in the ground (springs) in the forest and headload the water in pots to the village. Not only was this time-intensive, especially for the women and girls, but also fraught with the risk of running into elephants. A discussion around this issue with the community members at Kilcoupe village resulted in a plan to tap a nearby stream that flowed downstream from Kotagiri town.

Kilcoupe is an Irula hamlet that is classified as a forest settlement. It was set up as a village of Irula labourers who had come to that forest to work on coupe cutting for the Forest Department. They had small pieces of land to farm, but their access to water was fragile. A water supply scheme used to bring water to Melcoupe village first and then to Kilcoupe, but it was now defunct. Initially, the water was stopped by the Melcoupe village and not allowed to flow down to Kilcoupe. Over time the pipelines were broken in a number of places by wild animals. Without adequate water for irrigation the people were unable to farm. The village did not have access to electricity or alternate sources of energy either.

The planning led by the community identified the stream as a potential source of water. The community used this stream for bathing. To avoid conflicts with downstream villages, only a small part of the stream flow was channelled to a silt trap near the stream bank. This water was then taken through a pipeline by gravity to Kilcoupe village over a distance of more than three kilometers.

"It was an amazing feeling - the moment the water started flowing into the village", says Pratim Roy, Founder-Director of Keystone, recalling one of the earliest interventions of Keystone. "While we brought year-round supply of water to the village, we later realised that the stream water coming from Kotagiri town was polluted and was unfit for drinking. We tested the water sources and found that there was a clear link between the presence of faecal coliform and the water-borne diseases that they were suffering from. We raised awareness regarding boiling water before drinking as an appropriate way to address this and it was picked up well by the community."

Laying the pipeline at Kilcoupe

This intervention inspired the communities to take up farming again and the Forest Department to build a large check dam across the stream and provide irrigation to the village. This work on water supply related issues in Kilcoupe is not only an example of eco-development but also the action-reflection cycle that would typify Keystone's work in the decades to follow. This experience with a surface water-based water supply system and the inherent issues of pollution that come with it in the Nilgiris context perhaps laid the foundation for Keystone's work on water, particularly groundwater, over the coming decades.

SETTING THE CONTEXT

The Nilgiris district is fully contained in the Nilgiri Biosphere Reserve (NBR), the first biosphere reserve in the world, and is an area of significant biological and cultural diversity. It is a part of the Western Ghats, which is a global biodiversity hotspot and is home to six Particularly Vulnerable Tribal Groups (PVTG). The NBR, which includes the important urban tourist destinations of Ooty and Coonoor is growing in popularity with domestic as well as foreign tourists.

The Nilgiris district is approximately 130 km wide and 185 km long, with a geographical area of 2,465 sq. km[1]. It has undulating topography with steep slopes that are often cultivated. The elevation varies from 900 m to 2636 m AMSL. The temperature varies from a minimum of 20°C to 25°C.

Nearly 60 % of the district population was urban in 2011. According to the State Human Development Report (HDR) in 2017, the district ranked 24th out of 32 districts in the state in the Human Development Index (HDI), at 0.624. However, the district led the state in terms of the Gender Inequality Index (0.036). The GINI coefficient for urban areas was significantly higher in the Nilgiris (0.361) than the state average (0.338), indicating greater income inequality in Urban Nilgiris. The Infant Mortality Rate was low in the district (12.75) compared to the state as a whole (21) in 2013-14[2]. The literacy rate, according to the 2011 census, was 85 %, which was better than the state and national levels.

Prior to the arrival of British settlers in the Nilgiris, the population was largely

1 https://en.wikipedia.org/wiki/The_Nilgiris_District

2 Human Development Report, The Nilgiris, 2017.

composed of tribal communities such as Todas, Kotas, Kurumbas, Irulas and others. With the coming of the British the region opened up and there was migration of other non-tribal communities from the plains. The Badagas are a local community, pre-dating the British arrival, who are progressive farmers involved in tea and vegetable cultivation as well as in jobs in the service sector. Among the local communities, only the Badagas adapted to the changing circumstances and flourished.

Tribal people today form a small minority in this region (See Table 1). Migration of the youth to the plains areas for employment and studies is common. The Nilgiris district has had a negative population growth since 2001, probably owing to this trend.

Over the last few decades the area has seen the growth of settlements of repatriated Tamil people from Sri Lanka. Some estimates put the number of repatriates and their descendants at close to 25 % of the district population. It has also seen an increase in the number of people from the plains owning land and houses in the district as second homes. This is another factor contributing to the marginalisation of the tribal communities in the district.

Fig. 1. Map of the Nilgiris District (Source: Google Earth & GADM.)

The table below lists some of the demographic features of the district as per the Census of India 2011.

	Nilgiris	***Nilgiris Urban***	***Nilgiris Rural***
Population	7,35,394	4,35,655	2,99,739
Urbanization Rate	59.20%	-	-
Average Household Size	3.7	3.8	3.6
Sex Ratio	1042	1034	1054
Child Sex Ratio	985	982	990
Scheduled Castes (% of population)	32.10%	34.20%	28.90%
Scheduled Tribes (% of population)	4.50%	2.30%	7.60%
Literacy Rate	85.20%	88.00%	81.20%
Male Literacy	91.70%	93.40%	89.30%
Female Literacy	79.00%	82.80%	73.50%
Total workers (% of population)	52.30%	48.00%	58.60%

Table 1: Statistical profile of the Nilgiris – Urban and Rural

(Source: Census 2011)

Economy and Livelihoods

Tourism is the mainstay of the economy of the district. An estimated 3.5 million tourists visit the district every year. More people in India with disposable incomes and the proximity to cities such as Coimbatore, Mysore and Kochi are contributing to increased tourist activity in the region. The tourism sector is run primarily by private entities, with the government involved in managing tourist sites as well as in organising events to popularise tourism in the Nilgiris. Recently the Forest Department, along with tribal communities, has also started promoting eco-tourism in many areas.

However, the expansion of tourism has not been planned or well-regulated[3] and consequently infrastructure such as accommodation has developed in an ad hoc manner. Home-stays and hotels are found not only in the towns but also in villages and in wildlife corridors. Such rapid expansion has resulted in the withdrawal and contamination of water resources and the proliferation of solid waste in the region.

The major livelihood opportunities are farming and wage labour in tea estates. Around 43,000 ha in the district are under tea cultivation. There are government-owned and private tea estates in the Nilgiris that offer wage employment opportunities. Small tea growers have also increased in number due to the efforts (including subsidies) of the United Planters Association of South India (UPASI) and the Tea Board. These also present local employment opportunities for wage labour in and around the villages, especially for women. Over the last few years, with wage rates for labour increasing, labour is being imported from the Northern states as large estates find that more economical. There are also attempts being made to mechanise some of the activities involved in managing tea estates in order to reduce labour costs.

3 Dr. Gadgil, Madhav et al. Report of the Western Ghats Ecology Expert Panel (WGEEP). MoEF, GoI. 2011.

Plantation of Banana, a commercial crop

Animal husbandry is another occupation supported by the network of more than 100 dairy cooperative societies in the district. The Todas were once buffalo rearers, but now this activity has only a ritual value as they are engaged in a variety of other livelihoods.

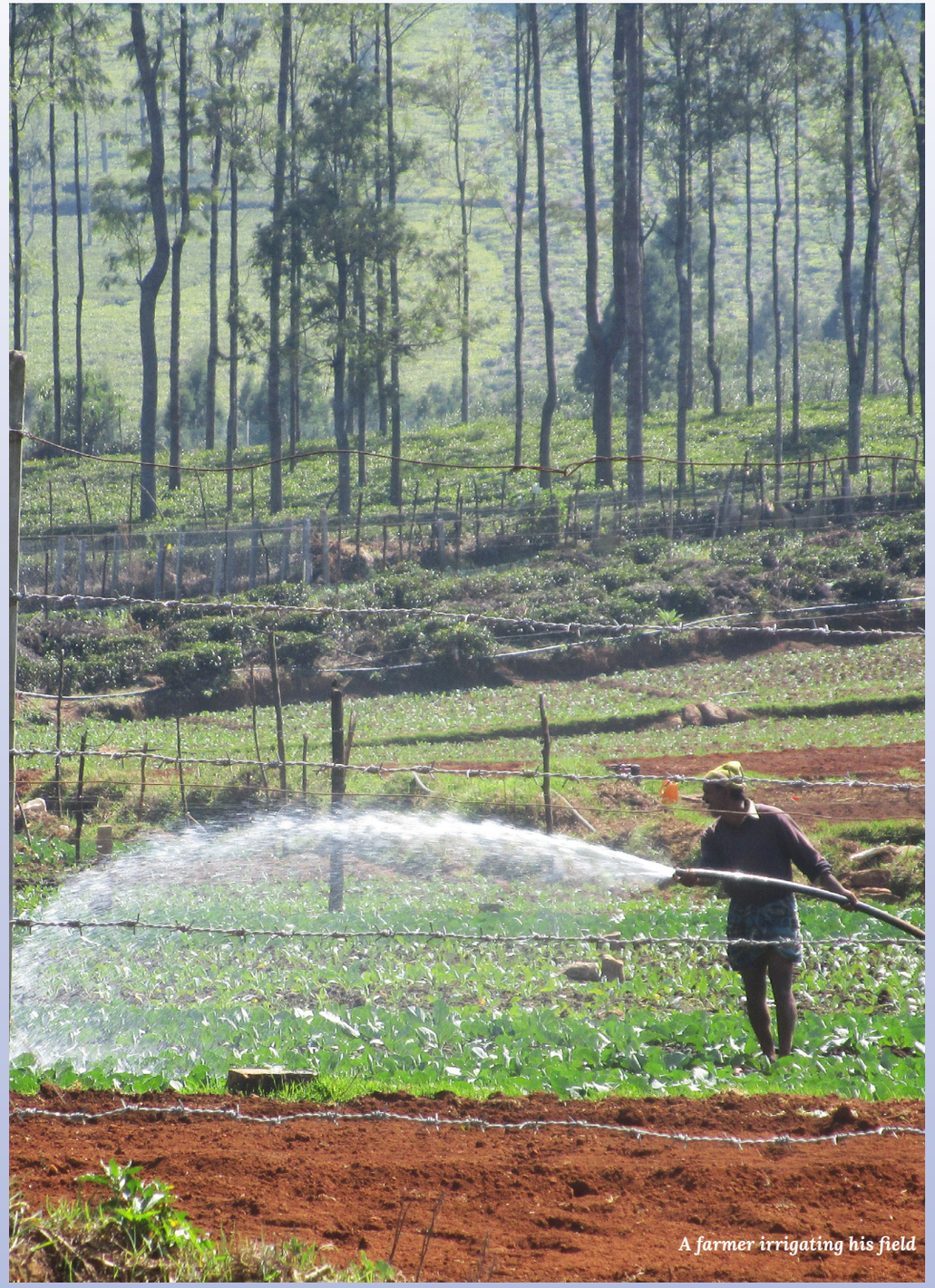
The indigenous communities used to cultivate millets in large areas for their own subsistence. However, cheap/free rice available through the Public Distribution System (PDS) has gradually displaced millets from the daily diet of the indigenous communities. Over the decades, with changes in dietary pattern, introduction of cash crops and increasing human-wildlife conflict, the practice of growing millets has declined to a great extent.

Given the high investment in solar-powered fencing to ward off wild animals such as elephants, gaur, boars etc., the tendency is to opt for irrigated cash crops where feasible, rather than millets, which are more nutritious and organic. This has implications for the nutritional security of indigenous communities as well as the water resources. The cultivation of 'English vegetables' is increasing in the Nilgiris, with farming throughout the year to supply to the main market in Mettupalayam.

The available data, though a bit dated, show the changes in cropping pattern between 2008-09 and 2016-17 in the district. Notable changes include a reduction in Net Sown Area, Current Fallows and Cultivable Wasteland along with a manifold increase in Other Fallows, which have been uncultivated for a period of more than one year and less than five years.

Though the cost of cultivation is going up owing to human-wildlife conflict, the returns are increasing due to the market-oriented nature of the crops being grown. One of the major impacts of such changes is the deterioration of water resources, in terms of availability and in terms of quality, due to the use of inorganic inputs.

Economic priorities have dictated the trajectory of development in the Nilgiris over the last three centuries. Shola forests and grasslands that once dominated this landscape were converted to plantations of exotic species that had commercial value. Perennial rivers were dammed and their water flows massively diverted to new courses for production of electricity. The urbanisation of the district has been based largely on indiscriminate modification of the topography disregarding the slope, geology, land use, climate and other factors. These and other changes have made the region vulnerable to landslides, biodiversity loss, drought, floods, soil erosion etc. They have also profoundly altered the relationship between people, biodiversity and water.



A farmer irrigating his field

S No.	Classification	Area (Ha) 2008-09	Area (Ha) 2016-17	Change over time (Ha)
1	Forest	142577	142577	0
2	Barren and Uncultivable Uses	3375	3402	27
3	Land put to Non-agricultural Uses	9976	9978	2
4	Cultivable Waste	2018	1441	-577
5	Permanent Pastures and other Grazing land	5078	5078	0
6	Land under Miscellaneous Tree Crops and Groves	3779	3764	-15
7	Current Fallows	8304	4785	-3519
8	Other Fallow Land	1857	8189	6332
9	Net Area Sown	77520	72571	-4949
10	**Total Area**	**254885**	**254885**	**0**

Table 2: Comparison of Land Utilisation in the Nilgiris

(Source: District Statistical Handbooks)

People and Water[4]

This district is home to various indigenous people including the Kurumbas Alu, Jenu, Mullu and Betta), Kasava, Irula, Toda, Kota, Kattunaika, Paniya, Badaga, Thoraiyya Badaga and the Mountadden Chettis. Each of these communities has favoured a different elevation for their habitations. The land use at these elevations has evolved to suit the livelihood requirements of these communities. Water use follows these land claims. Table 3 summarises the natural environment, social demography and water flows.

	Higher than 1800m	***1000-1800m***	***Lower than 1000m***
Natural forests	Shola, grasslands	Moist and dry deciduous	Dry deciduous and scrub
Commercial forests	Cinchona, eucalyptus, pine, wattle plantations		
Indigenous communities	Todas, Kotas	Alu Kurumbas, Irulas, Betta Kurumbas	Betta Kurumbas, Irulas, Kattunaikans, Paniyas, Kasava, Mullu Kurumbas
Other communities	Badaga, Tamils, Malayalis, Kannadigas, Sri Lankan Tamil repatriates	Badaga, Tamils, Sri Lankan Tamil repatriates	Malayali, Tamil, Sri Lankan Tamil repatriates

4 Keystone Foundation. Report of the Hill Waters and Livelihoods Project. http://www.indiawaterportal.org/sites/indiawaterportal.org/files/nilgiri_water_resources_project_-_final_report_0.pdf

	Lower than 1000m	1000-1800*m*	*Higher than 1800m*
Water Resources	Mostly polluted water enters the Reserve Forests zone, passing through scattered tribal hamlets and large wildlife reserves. All *hallas* (streams) merge into the four basins through the few major rivers. The water carries massive top soil and wastes. In the monsoon, water sources are visible, but during the summer most of them are dry. The plantation sector suffers, and the reservoirs are half empty.	Streams become rivers and pass through urban and rural settlements. It is mostly a plantation and agriculture sector. The sources of pollution in this zone are domestic waste as well as industrial and chemical waste. There are large concentrations of populations, including immigrants, tribals, service sector professionals, and the business community, all of whom use waters in diverse ways.	Water is trapped in the grasslands and sholas, releasing itself gradually through springs, marshes and swamps. There is a network of hydroelectric projects for electrical power generation. The landscape has large reservoirs. The source of pollution in this zone is agro chemicals.
Cultivated crops	Coffee, pepper, jackfruit, silk cotton, tea, ginger, paddy (Gudalur), millets	Tea, coffee, pepper, jackfruit, silk Cotton	Tea, flowers and vegetables
Trade and business	Homestead produce, wage labour, tea (Gudalur), farm income	Timber, tea, small business, wage labour, homestead produce	Timber, tea, tourism, township

Table 3: Altitudinal Zones in the Nilgiris

The indigenous communities have a special relationship with water sources such as springs and wetlands.

The **Badaga** settlements, known as *hattis*, mainly on hilltops, have depended entirely on upper spring sources close to shola forests and grasslands. In most Badaga villages, an underground source or *Huttu* (emerging) *neeru* (water) provides drinking water. This water is considered to be pure and these water sources are protected and worshipped and are out of bounds for outsiders, thereby reducing the risk of external contamination. *Halla Paruva* is a festival celebrated by the Badagas to worship water. The ritual takes place near a spring which is the source for wetlands. It is held once a year during the dry season between February and May in different areas across the Nilgiris.

Today, since sufficient water from upper spring sources is not available, Badagas have to depend on lower valley sources as well for their drinking water.

In the past, families used to maintain water channels from the source to the settlement by removing blockages and de-silting. This community effort led to everyone taking responsibility for the water system. Today, this practice has been discontinued since the government has brought in piped water and the water channels have become state-owned property. The management is different, with a few salaried people doing all the work. The government water supply is often insufficient in summer, and the old *Baavi* (well) is used then.

The buffalo is a leitmotif (guiding motif) in the secular and sacred lives of the **Todas**, a once pastoral community. Changes in the landscape have led to shrinking habitats and availability of water and grass for the buffalo. According to one Toda elder, "The Nanjanad area was a zone of large swamps - almost 20-30 kms wide and so long that the crossing would take time. These areas had good clean water sources from springs and grass on which our buffaloes fed. The government introduced pine, wattle and blue gum which dried up the swamps. With dryness the land developed cracks and with the risk of slipping into the swamp mud our buffaloes were unable to walk on these pasture lands".

Buffaloes grazing

The **Alu Kurumba** are a forest dwelling tribal group. They have found work as tea estate labourers, and over the last two decades have moved to live on the fringes of roads. Many of them still return to their homes within the thick forests, where they cultivate annual crops such as coffee and jackfruit. The Alu Kurumba in Pudur Kombei village recall how their drinking water flowed through bamboo poles, used as pipes to bring in water from uphill mountain springs. Today, they find it more convenient to use PVC-pipes and plastic buckets.

The **Betta Kurumba** from Vaacikolli village of Devarshola town panchayat use banana leaves to collect rainwater from the rooftops. Their regular water supply is from a waterhole nearby.

According to the Alu Kurumbas the wild willow or *Baige* tree is a good

indicator of the presence of water. They believe that its roots attract water and springs are formed in its vicinity. In Bellathi Kombei village beyond Manjoor, the Alu Kurumbas dig holes for water near these trees.

In the village of Kurumba Medu near Yellamalai, the Betta Kurumbas still practice the tradition of drawing water from a spring or a swamp. They do not fetch water from the wells as they consider it "dead" water. Though there is a well close to the village, nobody uses it. They go far down the valley to fetch water in vessels from the springs.

In most parts of the district, the source of a spring is a sacred place, out of bounds for women due to menstrual taboos. However, in a **Paniya** village in *Melambalam*, it is a *Moopathi* – a priestess - who performs the ritual pooja to raise the water table of the well.

This traditional connect with water sources has been eroded over time with the government and panchayats taking over the responsibility of providing water to the villages and towns. With growing settlements and an increasing demand for water, there is a disconnect with the resource base that provides it. There is a growing market for bottled or tanker water to meet this demand, but mining of water resources coupled with uncertain rainfall and minimal efforts to harvest it are making it unsustainable.

Water supply system in a village

Traditionally, the indigenous communities in the Nilgiris were intrinsically linked to the wetlands. See Figure 2). For instance, proximity to wetlands was one criterion for establishing Toda settlements (*munds*), and the Kotas depended on clayey soil from the wetlands for pottery, while Irulas and Kurumbas used to hunt around the wetlands.

Known today as agriculturists and tea growers, the Badagas were pastoralists who owned far more buffaloes than the Todas. The wetlands divided the Toda *munds* and *hattis* (Badaga settlements) and often belonged to a particular village with buffaloes from that village grazing there. The buffaloes supplied milk and so formed the backbone of their economy. The buffalo hides were given to the Kotas in exchange for the axe-like agricultural instrument which the Badagas used for ploughing. The Kotas sold the hide in exchange for iron ore and other goods in the market. Since the buffaloes depended on the wetlands, they were well protected. The swamps in the forests were called *Adavi* and the *Badagas* believed that the genesis of the buffaloes was from these *Adavis*.

The Badagas also believed that the wetlands were linked to the streams and other water bodies in the region and so had to be maintained and protected. Beragani and Nedugula were huge wetlands which had spiritual and cultural significance.

But over years the importance attached to these wetlands is changing. Since the Badagas shifted from buffalo rearing to agriculture, the significance of these wetlands and grazing lands dwindled. The threat to these wetlands began with the commercialisation of agricultural produce. The arrival of the British in the region increased the demand for vegetables. Moreover, post-World War II there was a huge worldwide demand for potatoes. Realizing the potential of these markets the Badagas started large-scale

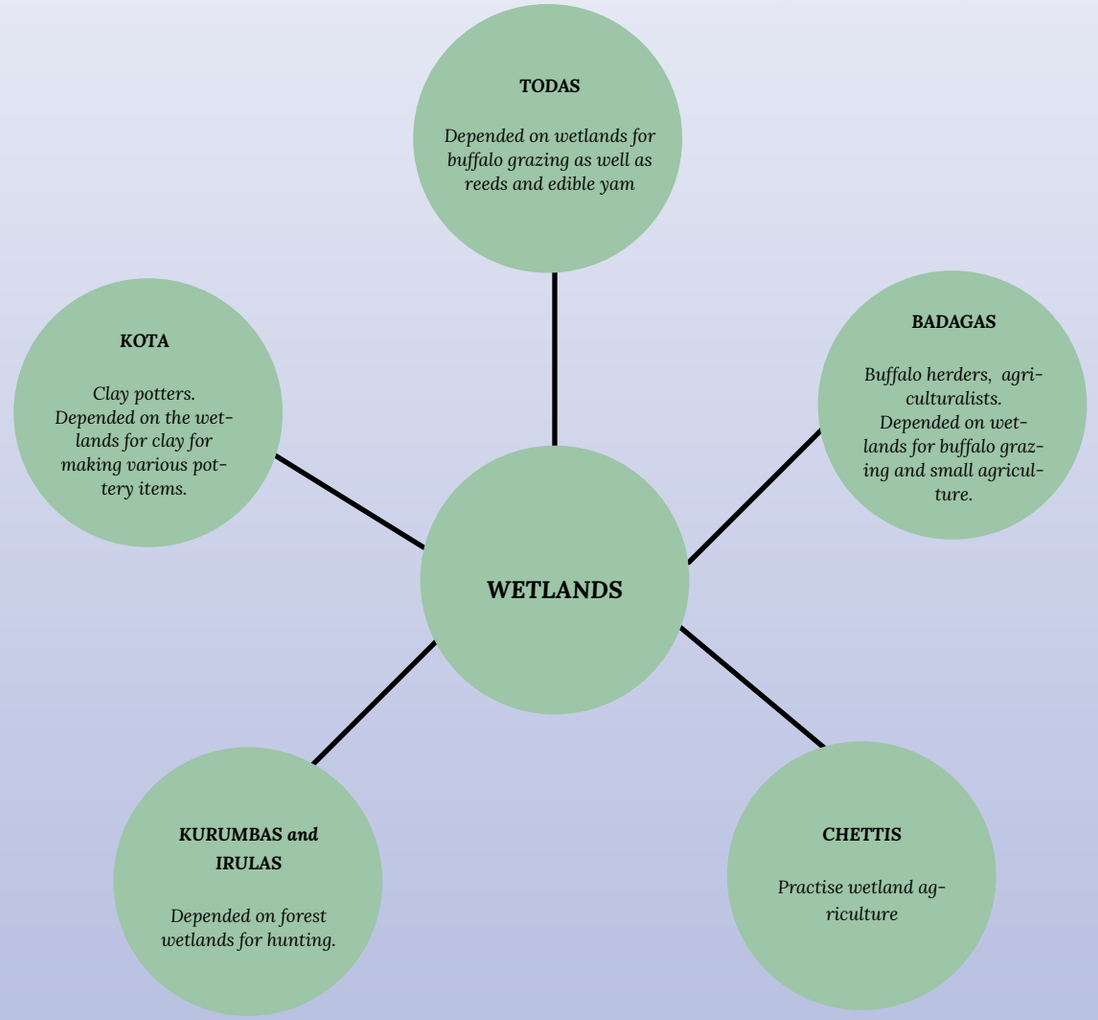


Fig. 2. Linkages of communities to wetlands

cultivation and in the process converted many of these wetlands into agricultural fields. The British turned these CPRs into '*patta*' or revenue land which also enabled/facilitated the conversion of these wetlands into agricultural fields.

So, the wetlands became insignificant and were converted to vegetable fields as a livestock-rearing community became an agricultural one. Further, the diversion of water resources for irrigation and industrial purposes also caused some of the wetlands to dry up.

The Kotas who are known in the region for their pottery skills depended on the wetlands for their supply of clay. They revered the wetlands and their cultural activities revolved around wetlands and pottery making.

For the Kurumbas and Irulas who occupied the lower elevations, the wetlands in the forests, being the source of drinking water for many animals, were easy hunting grounds.

The Chettis in the Gudalur region of the Nilgiris were forced to occupy the lowlands which were the wetlands. They soon adopted agricultural practices suited to this region. Earlier they grew paddy, but in recent times they have shifted to vegetable farming and horticulture, which are leading to the drying up of wetlands.

Toda buffaloes in a grassland

GROUNDWATER

Water is a State subject according to the Constitution of India. However, at the time of framing the Constitution, water was mainly thought of with respect to river waters and irrigation[5]. Groundwater with its own set of dynamics was not thought about then. As per the provisions of the Easement Act 1882 and the Transfer of Property Act, 1882, the landowner is supposed to have a right to groundwater beneath his land as it is considered as an easement of land. The Easement Act does not permit landowners ownership of groundwater if it is passing through in a defined channel. As much of groundwater is a dynamic resource which flows through defined channels, owners of land cannot claim absolute ownership over water under their land. The most important reason for the ineffectiveness of legal measures lies in the absence of any provisions to restrict the quantum of water extracted through existing groundwater structures[6].

In terms of policy, Tamil Nadu is in a unique position. Although the Tamil Nadu Groundwater (Development and Management) Act, 2003 was enacted by the State Legislature, it was never notified. In 2011, the Madras High Court ordered the State Government not to allow groundwater extraction for commercial purposes till the Act was notified. However the Government chose to repeal the Act in 2013 because many parts of the state do not have access to piped water and depend on groundwater

5 Ramaswamy Iyer, http://www.thehindu.com/opinion/lead/should-water-be-moved-to-concurrent-list/article2113384.ece.

6 Kamta Prasad Report (Institutional Framework for Regulating Use of Ground Water in India. A Report by Institute for Resource Management and Economic Development to MoWR, GoI).2008.

extraction by local bodies and private tankers. Therefore at present there is no law regulating groundwater extraction in Tamil Nadu.

During the summer of 2017, in response to severe drought conditions, there was a spate of borewell digging throughout the Nilgiris district. Given the hydrogeology of the district, borewells are not advisable. Where borewells are yielding water, they are competing with springs, wetlands and open wells in the same aquifer. In Sigur, borewell water often has high Total Dissolved Solids (TDS) making it unfit for drinking and cooking. Within a few months, the district administration banned the digging of borewells, thereby putting a stop to this inappropriate intervention.

In the Nilgiris, which is classified as a safe zone by the Central Ground Water Board (CGWB) based on the amount of water recharged annually as opposed to the amount of groundwater being extracted, there are issues of falling water levels and wells running dry on the back of monsoon failures. Springs and wetlands are the major groundwater resources in the Nilgiris on which people and wildlife depend. Until a few decades ago, gravity-based water supply from springs and streams was common across the Nilgiris. With increasing demand for water and the proliferation of habitations, the focus has shifted to open wells and, to a lesser extent, borewells, to draw groundwater using electric pumps.

Woman fetching water from a well

A Wetland and its catchment

Wetlands

Wetlands are parts of our landscape that are defined by the presence of water[7]. Many wetlands are transitional zones between terrestrial and aquatic ecosystems, while others may exist in upland depressions or where groundwater emerges onto the surface. Wetlands are the most biodiverse ecosystems in the world. Environmental degradation is more prominent in wetland ecosystems than in any other ecosystem on Earth[8]. Small hill wetlands, also known as swamps or marshes are critical life support systems in the Nilgiri Biosphere Reserve.

7 http://www.wetlands-initiative.org/what-is-a-wetland/

8 Davidson, N.C.; D'Cruz, R.; Finlayson, C.M. (2005). Ecosystems and Human Well-being: Wetlands and Water Synthesis: a report of the Millennium Ecosystem Assessment. Washington, DC: World Resources Institute.

Wetlands deliver a wide range of ecosystem services that contribute to human well-being, such as fish and fiber, water supply, water purification, climate regulation, flood regulation, coastal protection, recreational opportunities, and, increasingly, tourism. Wetlands deliver a wide array of hydrological services—for instance, swamps, lakes, and marshes assist with flood mitigation, promote groundwater recharge, and regulate river flows—but the nature and value of these services differs across wetland types. When both the marketed and non-marketed economic benefits of wetlands are included, the total economic value of unconverted wetlands is often greater than that of converted wetlands[9].

A Wetland

9 MEA. Ecosystems and Human Well-Being: Wetlands and Water.Summary.

Despite the importance of wetlands in the NBR and in other parts of the country, there had been no effort for a long time to inventory or manage the wetlands sustainably. Early assessments were marred by the problem of inadequate understanding of the definition and characteristics of wetlands (Gopal and Sah, 1995). The National Wetlands Atlas 2011 prepared by the Space Application Center is the most recent effort at mapping wetlands in India. More than 2 lakh wetlands were identified and mapped across the country on a 1:50,000 scale. In addition to these, more than 5.5 lakh smaller wetlands were identified as point features. The small hill wetlands that are so crucial to life in the NBR predominantly fall under the latter category.

Much of the attention of the policymakers and conservationists is on large wetlands such as those defined by the Ramsar Classification System. As a result, small hill wetlands such as those found abundantly in the Nilgiri Biosphere Reserve go largely unnoticed.

For centuries, dense forests and malaria had ensured that the region was largely undisturbed by outsiders. During the British period, wetlands were considered an impediment to 'development'. Swamps and marshes were dried to make the land fit for 'development'. The plentiful availability of water from springs, streams and wetlands meant that for more than a century the British could alter the land use drastically without facing the consequences of these actions.

Vegetable Cultivation

However, for the most part, the wetlands represented the state of groundwater in the region. They performed invaluable services such as groundwater recharge, flood control, water purification etc. In a high rainfall region with steep slopes, such services are essential to prevent flooding downstream.

In the Nilgiris, where hills with steep slopes support only tea, coffee or exotic tree cultivation (in terms of livelihoods) and traditional crops such as millets are restricted to only small tribal pockets, wetlands and the lands adjacent to them have been targeted for vegetable cultivation. The so-called 'English Vegetables' such as potatoes, carrots, cabbage etc. are grown as cash crops. In the Gudalur area, due to suitable weather conditions, wetlands are also used for paddy cultivation.

In 2011-12 a study by Keystone showed that the economic value of livelihood benefits derived by a local community due to a small wetland was as high as Rs 4.93 crores approximately, for 49 families engaged in vegetable cultivation. Other benefits such as grazing and water availability for buffaloes that have very high ritual value for the Toda community are impossible to quantify and value.

Unfortunately, despite the high value being derived from wetlands, there are not many practices to protect or conserve them. In fact, when Keystone made an effort to survey and talk to the community in one village, urging them to protect the remaining portion of the wetland in its natural state, there was a fear of imminent government take-over. The community members reacted by destroying the wetland vegetation overnight and putting the land under the plough. This type of economically driven behaviour typifies the lack of understanding among the communities today of the nature of water and land resources. The long-term thinking that formed the sustainable lifestyles of a few generations ago has been replaced by a need to monetise the natural resources through the few means available in the region. In this case it was through vegetable cultivation, in others it is to construct infrastructure or reclaim land for other uses. All these destroy the wetland ecosystem and the many ecosystem services provided by them. The delays in the feedback effect of this destruction on the availability of water, coupled with our management of water and land as separate 'departments' ensure that such diversions/conversions continue without lessons being learnt.

There was a general lack of awareness in the region about the importance of wetlands. Nor was there any systematic database of these resources. Knowledge of small hill wetlands seemed to be quite localised with communities being aware of the resources in their proximity but no list of small wetlands was available at the district level.

In this context, Keystone undertook a study of the 'Hill Waters and Livelihoods' scenario in the Nilgiris in 2001-2002. The study highlighted the fact that nearly 30 % of the habitations in the district depended on water sources that tapped wetlands. The high degree of dependence of communities on wetland resources for their livelihoods became apparent during the survey across different parts of the district.

To look at wetlands more closely, Keystone formulated a project to look at different community management systems as well as different user groups for wetlands. 38 wetlands in the Nilgiris were surveyed and a status report was prepared to capture and highlight the status of these important ecosystems and the challenges therein. The data were collected on a predefined format by interdisciplinary teams of Keystone staff who visited each wetland.

Most wetlands are Common Property Resources (CPRs) falling within the jurisdiction of the panchayat and utilised as well as exploited by people. Without any institutional arrangement around these commons these resources are open to exploitation. Some wetlands are private and managed primarily by tea or coffee estates. The rest fall under the category of protected areas and are usually under the jurisdiction of the Forest Department or within the domain of government departments and institutions. In some cases, the wetlands have been modified into dams. Some wetlands have been formed as a result of the creation of dams, where a stream or a river previously existed. The wetlands sampled in the Nilgiris have been classified as Urban CPR, Rural CPR, Private and Protected.

List of wetlands	*Ownership*
Bison Swamp	Protected - Forest Department
Eddapalli	Rural CPR
Emerald	Rural CPR
Tirsigadi-1	Rural CPR
Tirsigadi-2	Rural CPR
Tirsigadi-3	Rural CPR
O'valley	PVT
Konavakarai	Rural CPR
Burside / Pathimattam	PVT
Curzon	PVT
Mailoor	PVT
Kaatery	Protected - Defence
Mundakund	Rural CPR
Governor Shola	PA / FD
Rifle range	Urban CPR
Thalaikundah	Urban CPR
Longwood Shola	PA /FD
Denad	Rural CPR
Korakundah	PVT
Halakarai	Rural CPR
Nonsuch	PVT
Sandynalla	PA / Central institution
Happy Valley	Urban CPR
Cliffy estate	Rural CPR
Bikkapathy mund	Rural CPR
Thiashola	PVT
Manjoor Bazaar	Urban CPR
Amugal	PA
Tarnadmund	CPR/PA
Elada	PA / Kotagiri Panchayat
Raliah	PA /FD/Coonoor-Municipality/Defence
Manvayal	PVT
Bergani	Rural CPR
Nedugula	Rural CPR
Padanthorai	PVT
Kundikodmund/Lovedale	Rural CPR
Nadgani	PA/FD
Kinnakorai	Rural CPR

Table 4: Legal status of surveyed wetlands

Note: PA-Protected Area, FD-Forest Department, CPR-Common Property Resource, PVT-Private Land

Analysing the data collected from the 38 wetlands, Keystone developed the following typology of wetlands based on the land category in which they fell. A summary of the analysis is given in Table 5.

	Stakeholders	Major Issues	Management Plan
Urban Areas	• Washermen/women • Mechanics • Local residents, well owners • Small scale business like saw mills • Floriculturists • Small scale agriculturalists • Panchayat/Municipality	• Encorachment • Conversion to residences or kitchen gardens • Garbage dumping • Sewage inflows • Groundwater extraction through wells • Original wetland vegetation is disappearing • Lack of ownership over resource among local (diverse) communities	• Stakeholder Analysis • Facilitating multi-stakeholder process to develop norms and rules for the equitable and sustainable use of the resource and systems for garbage disposal, water management, preservation of wetland. • Clearly defined roles and responsibilities of each stakeholder • Awareness generation, particularly among youth and children in wetland restoration and conservation. • Ecological restoration of the wetlands to its natural state, to the extent possible. • Community development and poverty alleviation measures. • Monitoring of the management plan
Rural Areas	• Local residents, well owners • Farmers • Nearby villages • Panchayat, Municipality • Eucalytus oil distilling units	• Biodiversity has degraded in the wetlands • Shrinking of wetlands due to encroachment and diversion for other uses including construction, farming etc. • Contamination from solid and liquid waste, faecal coliform contamination, pesticide runoff • Unregulated extraction of groundwater	• Beneficiaries contributing to incentives for conservation of distant wetlands by local communities • Proper disposal of waste • Regular monitoring of water quality • Conversion of farming to organic
Private Land	• Private estates • Nearby villages	• Value of wetlands not appreciated • Diversion to 'productive' uses • Extraction of water from wetland for irrigation, water supply etc. • Contamination from chemical runoff from estates • Issues over access of common water resource by other stakeholders such as nearby villages	• Minimizing chemical use and shifting to organic practices • Maintaining a chemical free buffer area around wetlands • Increasing awareness regarding the importance of wetlands • Encourage estates to undertake Ecological restoration of wetlands • Study the impact of wetland biodiversity and services on the estates.

	Stakeholders	Major Issues	Management Plan
Protected Area	• Forest Department • Nearby villages – Tribal and Non-tribal, forest settlements • Tourists, Resorts	• Littering • Illegal uses such as fishing • Threat of invasive species displacing native vegetation in the wetlands	• Monitoring and removal of invasives • Enforcement of rules regarding tourism, limiting tourist load, • Tourism revenue should be ploughed back into the conservation of the ecosystem and to support dependant local communities

Table 5: The typologies of wetlands found across the Nilgiris

Note: Summarised from the final report of the project 'Wetlands Conservation & Sustainable Management in the Nilgiris' by Keystone Foundation.

Tarnadmund was home to 25 Toda families and has the biggest temple amongst all the Toda villages. Keystone had several discussions with the elders and gathered valuable information from them. The elders spoke of facets of Toda life including their history, culture and relation with wetlands. According to them, the foremost criteria for establishing a *mund* are the presence of shola, grasslands (grazing) and wetlands. In Tarnadmund, the origin of the wetland is adjacent to the village. Traditionally, the shola and wetland landscape extended to over 200 acres. The wetland was earlier surrounded by grasslands and shola forests but is now engulfed by agricultural fields. Tarnadmund had more than 30 acres of cultivable land, which was in fact mostly a wetland.

Currently, the land is cultivated partly by the Todas themselves and partly by lessees (a large number of whom are non-tribal) on a partnership or lease basis. There are two types of cultivated land, namely irrigated and rainfed. The elders said that the area of land cultivated depends on the availability of water in that particular season. They also said that there would be no further expansion of cultivation at the expense of the wetland area.

The elders spoke about the threats to shola forests and grasslands. Tarnadmund has ample land for grazing and the pure line of Toda buffaloes is found here. However, with the increase in grazing pressure, shola patches seem to have shrunk. If a fire destroys a shola forest, the dependent wetland also dries up. The eucalyptus and acacia trees planted by the Forest Department are to blame for the drying up of numerous wetlands in the region, as the eucalyptus trees tend to drain out water from the surroundings. When a eucalyptus tree is cut, a huge amount of water pours out from the tree. If a particular shola is the source of a wetland, the elders impose certain norms such as a ban on fuelwood collection, to protect it. In order to protect the shola forests, they say that the trees should be planted close to each other as the intertwining of their roots enhances their growth.

In the earlier days the wetlands had many seasonal flowering plants as well as tubers and yams which were consumed by the community. However, over the past few years, with the decrease in sholas and increase in agriculture in the adjacent lands, these plants have disappeared.

The elders said that the younger generation was fully aware of the significance of wetlands and would ensure that they are conserved. They still celebrate with the same enthusiasm as before, a festival in which salt is added to wetlands and the buffaloes are made to drink the salty water. This is followed by a traditional game of chasing the buffaloes around the wetlands and catching them.

The Todas claimed that they are particular about extracting only specific species from the shola forests, such as reeds and timber. Grazing lands are clearly demarcated, and a check is maintained on the level of use/extraction[10].

10 The final report of the project 'Wetlands Conservation & Sustainable Management in the Nilgiris' by Keystone Foundation (https://nilgiriswaterportal.in/download/16/).

A Wetland in its natural state

However, most of the wetlands were facing threats from encroachment, diversion of wetlands for construction, invasive species, drying up due to plantation of exotic trees in upstream areas etc. The lack of legal recognition coupled with pressure for land from various stakeholders has led to a decline in the quality of wetlands. Most of the wetlands showed signs of degradation through conversion to agriculture, being drained out, pollution, over-exploitation, real estate development and fishing. Biodiversity, though still present in many of the wetlands, was vulnerable to any changes in the wetland ecosystem. The wetland loss has been responsible for bringing many species of animals and plants to the verge of extinction. Inadequate understanding of the crucial role and utility of wetlands is a matter of serious concern.

Historically, most wetland losses were due to agriculture. Today, the most common threats to the Nilgiris wetlands are urban development and farming. The fertile soil and location make wetland areas attractive for farming as well as business and housing developments, and form localized high population zones within the Hill District. There is immense pressure on these resources due to the expansion of lucrative intensive farming and the ever-increasing demand for infrastructure.

Invasive species such as wattle, *Ulux spp*., *Cytissus spp*., and *Lantana camara* have spread over all the sites. Exotics such as eucalyptus are found in upland regions along most of the protected wetlands. Visually, there seems to be a lot of water around the trees. The trees are always found planted at the higher lands and near the source points.

Most vegetable growers are located in valleys close to wetlands. In most cases, there appears to be unrestricted access to water and no controls on the inputs of agriculture. The chemical runoff is very high. The use of wetland resources has been taken to extremes, with tea plantations being raised till the edge of the wetlands, and in areas like Gudalur, even on top of wetlands. The farmers are reluctant to leave the land fallow and plant it even though they know that it may not do well in terms of returns. In this process valuable ecosystems have been lost.

This has also resulted in most of the surveyed wetlands having a high probability of contaminated water due to chemical inflows.

Pesticide pollution of wetlands reduces the availability of aquatic insects essential for the growth and development of aquatic birds. The use of pesticides on farmland has further reduced the amount of safe habitat available for birds that already have to make do with small woodlots, hedgerows, shelterbelts, and farm ponds for nesting or feeding. Habitats bordering agricultural fields can become a liability if birds are attracted to the fields and inadvertently poisoned by toxic insecticides. Herbicide use in plantations may cause ground-dwelling birds to lose the leafy shelters that protect them against predators and bad weather. The potential for the herbicide spray to drift through the air and contaminate distant wetlands through water runoff is also a concern. In the Nilgiris the rampant use of pesticides has already led to decreased biodiversity. This is an area that needs focused research to inform policy and practice.

Pesticide containers discarded near a wetland

Many of the wetlands surveyed by Keystone were subjected to high levels of grazing. A review of the existing knowledge base suggests that grazing can be beneficial as well as detrimental to the wetland ecosystem. Local people have in fact traditionally nurtured wetlands mainly to provide fodder for their cattle. Yet, as observed in a number of places, pressure from cattle has increased manifold and the biodiversity levels in a large number of wetlands are shrinking. Grazing stunts the growth of vulnerable plants and wildlife is forced to compete with cattle for the limited amount of fodder available.

Keystone developed Management Plans for five of the 38 wetlands surveyed, namely Tarnadmund, Nedugula, Konavakkarai, Ralliah and Padanthorai. These five sites were shortlisted after intensive exploration and based on the social as well as biodiversity importance of the region. They were considered to be representative of the five categories of wetlands Keystone had defined (See Table 5). The Management Plans can be accessed at http://nilgiriswaterportal.in/download/16/.

As a result of the advocacy efforts undertaken through a stakeholder workshop where the study findings were shared with everyone, one of the wetlands being considered by the Hill Area Development Programme (HADP) for diversion was fenced off and protected. The HADP also provided financial support for wetland conservation in the district. To demonstrate a pilot intervention to conserve a wetland through ecological restoration in its catchment, the Happy Valley wetland in Kotagiri was chosen.

Happy Valley: a Model for Spring and Wetland Rejuvenation

The Mission Compound or Happy Valley wetland starts on the outskirts of Kotagiri and serves as the source for water supply for a significant part of Kotagiri town. It is the lifeline of Kotagiri, as there are more than 30 wells in the valley below the wetland, all drawing from the same aquifer. Intensive agriculture, which is a common feature in the lower reaches of the valley, is also dependent on it.

This case was an eye-opener for Keystone as it showcased both sides of human behaviour – that of preservation and of exploitation. The proximity of the wetland to the Keystone campus along with the fact that the source of water to the campus was a well in the same valley also contributed to the choice of this wetland as a pilot site in 2006.

Happy Valley Restoration Plot

The source of the wetland is a spring. The spring was surrounded by shrubs like *Lantana*, *Eupatorium*, *Cestrum*, *Solanum verbascifoliu*, *Ricinus* and *Pteris*. A small stream runs off from the spring. Along the course of the stream *Polygonum spp*., tree fern and *Cyathea* were found. The agriculture belt had *Rumex* and *Plantago spp*. Tea was planted in the upland portion of the wetland.

In 1968, the Panchayat constructed an underground check dam that acts as a reservoir and source for drinking water. Thus, while the spring water was available to the people the spring source remained protected from contamination. People recall that in the mid-70s the place near the spring was used for washing clothes. Around 1985, a youth group called the *Kotagiri Nanbargal Sangam* cleaned the area around the spring source.

Downstream from the source, the story is one of extraction for drinking water, for commercial purposes and for agriculture. Keystone counted more than 10 municipality wells and 50 private wells dug in several crucial places along the stream. By 2018, there were more than 30 wells within 250 m of the source, with the numbers increasing steadily.

The original wetland was diverted for use a few decades ago and today there are but traces of the native wetland flora. In its lower reaches, the wetland has been totally modified and intensive agriculture is practiced. Not a bit of space has been left vacant.

By the time the wetland stream reaches the confluence with the second branch it has already become a carrier of sewage and wastewater. Houses dotting the valley discharge their sewage and solid waste directly into the stream, leading to high levels of undesirable contaminants such as coliform, nitrates etc.

The second section of the wetland originates near the Sterling factory and covers its course undisturbed until its confluence with the first stream. From that point onwards, the big stream becomes a massive drain carrying nothing but sewage.

After the Coonoor Road Bridge the stream becomes a dumping yard for sewage, with more added by the slaughterhouse. By the time the water reaches the washing *ghat* it has become a repository for hazardous material. Beyond the washing *ghat*, the stream travels through tea plantations before finally meeting the Agaal stream. The residents living along the stream have contaminated water supply as their wells

are located close to the stream.

Keystone felt that the major reason for the pathetic condition of the resource was a lack of awareness of the importance of wetlands, springs and streams, and decided to carry out an awareness campaign. This was centred on a wetland walk along with the distribution of informational posters and other materials. School students, teachers, local residents, panchayat representatives and members of the Kotagiri Wildlife Association participated with great enthusiasm. This event was held, fittingly, on World Environment Day. Through discussions with the Town Panchayat, a one-acre plot of panchayat land in the catchment of the spring and wetland in Happy Valley was identified for ecological restoration.

Consultations with elders and resource persons from the local community revealed that the area had once been a shola patch. In fact, it was called '*Chinna sholai*' or small forest, as opposed to the '*Dodda sholai*' or big forest, which is the Longwood Shola. Therefore, as part of the ecological restoration activities, school students planted shola saplings in this plot. The saplings had been raised in a nursery in the Keystone campus. The far-sightedness of the panchayat representatives and officials must be appreciated as they readily granted permission to plant a shola forest on panchayat land. They also fenced off the area to protect the restoration efforts. Sanitary workers of the panchayat cleaned up the area, which was overgrown with weeds and invasive plants such as *Lantana* and *Acacia*. The site was being used as an open defecation site by a few neighbouring families. These families were given loans to construct household toilets as the fenced-off shola patch was no longer accessible to them. This brought the families who were directly dependent on the plot on board the conservation initiative.

From 2007 to 2012, replanting was carried out in the plot every year. The survival rate of saplings was 83 %. School children continued to be involved in these activities and in conservation education programmes in the plot. In 2018, the number of shola trees in this one-acre plot had grown to 425. An assessment done in 2015 on the status of the shola plot yielded the following comparison with respect to the baseline situation in 2006 (See Table 6).

Apart from the visible improvement in the shola patch in terms of biodiversity, there has been an increase in water flows as well[11]. While the spring discharge data has been collected only recently, it is worth noting that when other water sources nearby, such as Elada, had dried, the Happy Valley spring continued to provide a significant flow of water. This is not only an important source of water for the families living downstream of the wetland, but also for many institutions in the catchment. Gaur visit the area regularly, thereby proving that it has become an important source of water and food.

Parameter	2006	2015
Native plant species	5	26
Invasive species	6	3
Birdlife	2	10
Mammals	0	3
Wells	15	>30
Water level	Less in summer	Adequate in summer

Table 6: Impact of restoration activities in the one-acre plot at Happy Valley

Inspired by the work at Happy Valley, the Church of South India (CSI) school in Mission Compound allotted a part of its land for the planting of shola trees. This shola plot is now thriving and is contributing to the health of the wetland and stream. A case study of Happy Valley is a part of the Springs Initiative curriculum for training on springshed management across the country[12].

There has been considerable success in terms of restoration and reaping the benefits of water flows, but a few issues remain to be sorted out in the coming years. This is the only patch of panchayat land in the area so there is competition for space. Many local residents take the water flows for granted and want a community hall to come up in the shola plot. Some residents also call it Keystone *kaadu* (forest) due to Keystone's close involvement in the process over the years. In general there is a disconnect between the communities and panchayat assets across the district. This is the case with the Happy Valley as well. Sometimes the space is used as a den for anti-social activities.

The panchayat has a well-functioning waste collection system where segregated waste is collected from door-to-door. However, areas away from the main roads are typically left out of their reach. The waste in these areas is usually dumped outside the house and is either burnt or washed away in the rains. The proximity to streams also helps in conveying the waste away from the site of disposal. Valleys, where wetlands occur, are often areas that fall outside the waste collection network. In these areas there is a greater risk of the wetland being directly polluted by solid waste.

Keystone is planning a multi-pronged approach to strengthen the conservation efforts in Happy Valley. The area, including the restoration plot, spring box and check dam will be developed into a wetland park that will make the invisible (groundwater) visible and attract local community members as well as outsiders to experience the natural environment. This would help to garner greater support from the community to take care of this invaluable resource in the future. The waste management system in Kotagiri town is also being studied. Over the next few years Keystone will be working to strengthen this to cover important areas such as wetlands and springs.

11 https://www.thehindu.com/todays-paper/tp-national/tp-tamilnadu/eco-restoration-project-in-kotagiri-provides-safe-haven-for-animals-water-for-residents/article22653481.ece

12 https://www.indiawaterportal.org/sites/indiawaterportal.org/files/case_study_-_keystone_happy_valley.pdf

Happy Valley Restoration site in 2008

Happy Valley Restoration site in 2018

Children drawing water from Happy Valley Spring

Livelihood Linkages

In 2012-13, two wetlands (Tarnadmund and Nedugula) were studied to understand livelihood linkages and to calculate the economic value derived from the wetlands. In both the areas, more than 80 % of the families owned land in and around the wetland. Vegetables were being farmed in both cases, although in Tarnadmund the area being cultivated was one-third of that in Nedugula. While the value of annual agricultural output in Tarnadmund was approximately five lakh rupees, it was about 93 lakhs in Nedugula.

The wetland area has been a traditional grazing ground for the Toda buffaloes in Tarnadmund. While once they had as many as 500 buffaloes, less than a tenth of that remained at the time of the study. There is a strong cultural motivation for the protection of the wetland amongst the Todas, because of its connection to the sacred buffalo and its pasture. However, it is the lack of capital that has led to only a small portion of the wetland area being appropriated for vegetable cultivation currently[13].

During various small group discussions that were held to interpret the survey findings, an area that emerged as an important dimension of wetland use is tenure over the wetland. In Nedugula, where the wetland is located in private land, there seems to be very little community jurisdiction over the land use. In Tarnadmund, the wetland cuts across the Toda *patta* land, which is a revenue assignment to the Toda community. However, the current status of this land is unclear. The Forest Department claims 'ownership' over it, as does the community. Since the community has been using the said extent of land for grazing, they are eligible to claim tenure over it under the provisions of the Scheduled Tribes and Other Traditional Forest Dwellers' (Recognition of Forest Rights) Act, 2006. Pudumand, one of the habitations of Tarnadmund, has initiated the process of filing community claims over about 7 ha. of land, but there are competing claims to this land from the neighbouring village of Sholur Kokkal as well.

13 Keystone Foundation. Report of livelihoods linkages and economic value of wetland. http://www.indiawaterportal.org/sites/indiawaterportal.org/files/report_of_livelihood_linkages_and_economic_value_of_wetland.pdf

A transformed landscape

A New Methodology to Study Wetlands

In 2006 Keystone had marked the catchment areas of these wetlands, but subsequently there were no efforts by the government or any other agency to systematically monitor their status; there was no simple methodology to monitor the status of these wetlands. There was an urgent need to adapt existing methodologies to identify these and other wetlands and to assess them from social, economic, ecological and hydrological aspects. Thus in 2015-16 Keystone revisited a few wetlands with a new methodology that included the catchment of these wetlands as well. The wetlands covered were Elada, Rifle Range, Upputhotty and Thalaikundah.

High-resolution imagery available via Google Earth software was used to derive catchments and land use maps of these wetlands and to see changes over time. The complete lack of any concern for the fate of the downstream water bodies is evident from large-scale changes in land use in the catchments of important wetlands. In the case of Yedappalli wetland in Coonoor, whose catchment is mostly *patta* lands with wattle plantations on them, a new temple has come up in the last few years. It has reshaped a significant portion of the catchment into built-up area and lawns with exotic grasses. The wetland has also been modified by digging a pond and constructing a barrier to the outflow. An older temple located on the opposite hill in the same catchment has also expanded its footprint by building a road and cutting across the earlier extent of wetland. The large number of visitors to the temple adds to the waste management problem in this space.

Fig. 3. Yedappalli wetland in 2012 (yellow polygon)

Fig. 4. Massive land use change around the Yedappalli wetland in 2018

Yedappalli wetland in 2014

Case Study of Elada Wetland

In Kotagiri, the Elada dam is the main water source for the town panchayat. Over time there have been significant changes in the wetlands feeding the dam. Today the dam is not able to supply as much water as before due to a number of factors. The salient aspects of the Elada wetland are shared as a photo story.

Dam at Elada in Kotagiri taluk

Wetland above the check dam

Intensive farming in the valley above the dam

Farmlands separated from the wetland by a fence

Stream flow being interrupted

Section of stream in its natural state

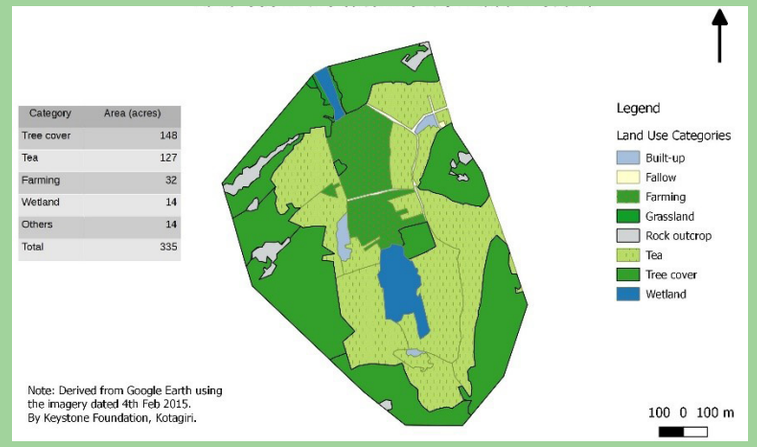


Fig. 5. Land use map of Elada catchment in 2015

Wetland being converted to farmland

Native grasses in the source wetland upstream

Fig. 6. Source Wetland in 2015

Fig. 7. Source Wetland in 2016

According to the local communities, the shola forests in the catchment have given way over time to wattle. The lack of protection to wetlands in the catchment of the Elada dam has resulted in commercial farming, leading to the destruction of the source wetland. There are more than 30 open wells in the catchment, used mainly for irrigation. All these factors together have led to a water scarcity in the region. This is another instance of a common property water resource being in private hands and being mismanaged for private gain with far-reaching negative downstream impacts.

Water Quality

Given the high loads of fertilisers and pesticides used in the farms and tea plantations in the Nilgiris, we had sediment samples and fish from three wetlands tested a few years ago. The tests were done by the Salim Ali Centre for Ornithology and Natural History (SACON)[14]. A few excerpts from their findings are given below:

• Many organic pesticides and trace elements are hydrophobic, that is, in aquatic environments they tend to be associated with sediment particles and biological tissues rather than dissolved in water. For this reason, sampling sediment and fish is an effective way to assess the occurrence of these contaminants in the aquatic environment.

• In sediments collected from the stream area of Tarnadmund and downstream, the agricultural field and pond areas of Nedugula, β-HCH and lindane exceeded the sediment quality guidelines (SQG), threshold effect level (TEL), the probable effect level (PEL) (Buchman 2008), and the maximum permissible concentration (MPC) (Crommentuijn et al. 2000), indicating the possibility of adverse effects to organisms. It is known that lindane causes endocrine disorders (CEC, 2003).

• Residues of p,p' DDD (36.11 ng/g) and o,p' DDT (33.27 ng/g) were the maximum in the downstream sediments of Tarnadmund. ∑ DDT residues in Bison Swamp sediments were BDL. DDE/ DDT levels measured in sediment samples of Tarnadmund and Nedugula indicated the use of DDT and slower degradation rates in these wetlands. The high incidence of DDE has ecological implications because

14 Pesticide contamination in select wetlands of Nilgiris district with special reference to sediments and fish. SACON. Report submitted to Keystone Foundation.

this metabolite is more persistent and toxic than DDT. Furthermore, DDE is known to alter metabolic functions in organisms by acting as an antiandrogen, binding to androgen receptors and inhibiting transcriptional activation, which causes reproductive abnormalities (WHO 2004).

Fungicide used in a farm

• Concentrations of ∑ HCH, ∑ DDT residues in 70 % of the samples included in the present study were higher than the levels reported by Vijayan and Muralidharan (1999) from various reservoirs, namely Avalanche, Uppar Bhavani, Emerald, Kamaraj Sagar, Pykara and Maravakandy, Ooty lake and rivers such as Coonoor and Moyar in the Nilgiris district.

• The Stockholm Convention (2001) named 12 persistent organic substances (POPs) or the dirty dozen that are considered to be extremely harmful because of their persistence in the environment, potential for bioaccumulation in tissues through the food chain and human and wildlife toxicity (Wei et al. 2007). Out of the 12 POPs, only one pesticide (∑ DDT) was detected in this study. In 2009, the Convention included 9 additional POPs, including α - HCH, β - HCH, and γ - HCH or lindane (Stockholm Convention 2009), which are detected in this study.

• It should be mentioned that the quantum of pesticide residues detected may not reflect the threat because the toxicity differs among pesticides. Apart from accumulation in animal tissues through food chains, high rainfall and laterite soil in the district facilitate the speedy leaching of toxic chemicals, leading to contamination of water bodies not only in the hills but also in the plains.

• Sediment provides a habitat for many aquatic organisms but is also a major repository for many persistent chemicals that are introduced into surface waters. The concentration of contaminants is often several orders of magnitude higher in sediment than in overlying water. Thus, the long-term release of low concentrations of chemicals into water can result in elevated concentrations in sediment. Contaminated sediment may be directly toxic to aquatic life or can be a source of contaminants for bioaccumulation in the food chain.

• Even if these pesticides are present in trace quantities in sediment, they are hazardous because they become a hundred times more concentrated in fish. Unfortunately, these chemicals are not always selective, and many have adverse effects on non-target organisms.

Outreach and Advocacy

Over the next few years, Keystone plans to test samples of water from rivers and wetlands in the Nilgiris for pesticide contamination. It is imperative that such data be available in the district as they are critical in evaluating the land use pattern. This in turn is important for advocacy efforts at the district and state levels as that is the only way large-scale changes in the region are possible.

Keystone has made constant efforts at advocacy with the district administration of the Nilgiris as well as with civil society groups, to draw their attention to the importance of wetlands and the need to conserve them. This effort has been supplemented by the sharing of all the data and information pertaining to Keystone's work on water in the public domain via the website https://nilgiriswaterportal.in.

One of the citizens' groups in Coonoor approached Keystone after realising the wealth of information available on the water resources situation in the Nilgiris. Since then Keystone has been partnering with groups based in Coonoor, Ooty and Kotagiri to support citizens' initiatives on wetland conservation and waste management. Institutions like the Providence College for Women, Coonoor have also actively participated in conserving their water resources and in protecting the nearby Upputhotty wetland. In many Badaga villages where wetlands and springs have traditionally been worshipped, the restoration of shola and native grassland species has been initiated. The district administration of the Nilgiris has also started wetland conservation as a priority intervention with the participation of civil society groups. As a first step, the ecological restoration of a wetland in Ooty town has begun.

Ecorestoration in a wetland

Clearing invasive plants

Springs

Local water resources are critical to sustain life in any region, and more so in hilly areas where the topography makes it challenging to transport water over long distances. In the Nilgiris, springs have had a major impact on the water resource distribution in the region.

Springs are places in the soil or rock where groundwater emerges naturally. This could be a single point or a set of points close to each other. Springs that flow throughout the year are called perennial springs, and those that dry up for some time each year are called seasonal springs. While beautiful waterfalls and fast flowing streams catch the eye during the monsoon season, the sustenance of the local inhabitants depends on the mostly invisible springs. Often the spring discharge is seen only in the form of a stream. Springs are a lifeline of the Nilgiris and have been appreciated as important sources of water, both by the state, through the construction of spring boxes, and by the people, through cultural practices such as festivals.

Springs, the indicators of the health of the aquifers, have been worshipped by many communities over centuries. Even today, springs are part of the cultural and religious practices of tribal and other indigenous communities, who perform annual rituals at spring sites and observe various norms regarding the use of spring sites. The Badagas have an annual festival called the *Halla Paruva*, which is performed at the spring site before the monsoon season in order to get a good rainfall. It is not uncommon to see a small shrine or a temple next to an important spring.

Small springs are often located at the base of a native tree such as the Indian willow. Most of these springs have

An old spring box

Halla Paruva festival in Horasholai village

a low discharge in the order of a few litres per minute at the most, but they provide enough water throughout the year to meet the needs of a few households that typically comprise a remote tribal habitation. They are a good source of fresh clean drinking water as there is a strong belief across communities that spring water is pure water.

In the hills, many old villages are located close to springs. Even today, a fair number of villages in the hills depend on springs for their water supply, either as the only source or in addition to other sources of water such as wells, streams etc. Often, when streams or wells dry up in summer, people depend on springs to provide clean drinking water.

Springs are the sources of rivers and streams in the southern hills. In the absence of glaciers that feed the northern rivers, the dry season flows in southern rivers are maintained by springs. By slowly releasing the water stored in aquifers into the streams and rivers, springs ensure that various forms of life, including humans, are able to survive even when there is no rain for prolonged periods. When the streams and water bodies dry up, wildlife too depend on springs for drinking water and this often leads to conflicts with people.

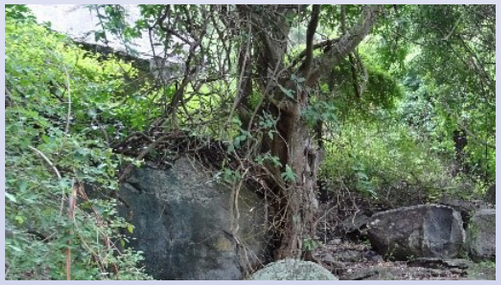
The water flow from a spring depends on rainfall. While most of the rainwater is lost as surface run-off, a part of it percolates underground and gets stored in fine pores in the soil and cracks in the rocks. The greater the volume of rainwater being recharged underground, the more will be the outflow from the springs in the non-rainy period. Dense vegetative cover of trees, shrubs or grasses, trenches and pits help increase the volume of water that infiltrates underground. It also helps to filter and improve the water quality.

A natural spring in a tea plantation

Depression springs occur due to a sudden change in a slope causing the water table to cut the surface. The recharge area of such springs is typically just above the spring. The wetlands in the Nilgiris, which are important ecosystems in themselves and are a vital source of water, arise out of springs of this type. Fracture springs, as the name suggests, occur along fractures in the water-bearing rock. The recharge area of such springs is along the fractures above the springs. Contact springs emerge at the contact of two different rock types, with the rocks below being impermeable and those above being permeable. Determining the recharge areas of the fracture and contact springs is not as straight-forward as that for the depression springs. Depending on the geology and the slope, the recharge area of a spring may be in another watershed entirely. Hence the concept of a springshed is not identical to that of a watershed. Sometimes there could be a combination of such springs.

People have observed that over the years there has been a reduction in the discharge from many of the springs. A lack of appreciation of the technicalities of the functioning of a spring and the absence of any concerted efforts to identify and protect the springshed

is a possible reason for this. Global phenomena such as climate change also have a role to play, through the increasing uncertainties in rainfall. Deforestation, landslides and developmental activities such as construction of houses, roads etc. disturb the catchment area of the springs and can result in reduced infiltration into the groundwater. In some cases, they may be directly impacting the springs themselves. Increased extraction of groundwater through open wells and borewells in and around wetlands may reduce the groundwater available for



A natural spring inside a forest

discharge through springs. Improper disposal of sewage and other waste in and around the springs can contaminate the groundwater thereby reducing the effectiveness of the springs.

The importance of springs in the Nilgiris was highlighted by the Hill Waters Study as well as the hydrogeological profiling of catchments of water sources of Coonoor town. However, over the years, the increasing demand for water meant that the new water sources being developed in the villages were mostly open wells, with springs being largely neglected. Even the traditional connect of the indigenous communities with springs seems to be diminishing with time as other sources gain importance. At present there is no estimate or inventory of springs in the country.

In this context, Keystone became a part of the Springs Initiative network in the country and started working on a baseline survey of five village panchayats in the catchment of the Coonoor river. During the baseline survey, nearly half of the habitations stated that they were dependent on springs for their water supply (Table 7). However, cross-checking the sources, revealed that springs and wetlands were often used synonymously. These were separated and it turns out that one-fourth of the habitations are dependent only on springs for their water supply. Another 18 % have springs as one of the sources, while 41 % have wells as their only water source. In all, 87 % of habitations in the five village panchayats depend only on groundwater for their water supply.

Keystone undertook a sudy in 2016 on the economics of water access by communities in the region using life cycle cost approach. The methodology was adapted from the Water Sanitation and Hygiene Cost Project (https://www.ircwash.org/washcost). This study showed that in villages with springs as the only water source or as one of water sources, the total cost of supplying water was lower than villages without any spring water source. In the latter, a considerable amount of cost was incurred by the community members in order to access the water, in addition to investments by the panchayat. This underlines the significance of springs as water sources in the Nilgiris.

Table 7: Sources of Water Supply to habitations in five village panchayats in Coonoor

S No.	Panchayat	Total No. of habitations surveyed	Habitations dependent only on springs	Habitations dependent only on open wells	Habitations dependent on springs and open wells	Habitations dependent on springs and streams	Habitations dependent on streams and wells	Habitations dependent on streams only	% Habitations dependent on groundwater
1	*Hubbathalai**	31	7	18	5	0	1	0	100
2	*Berhatty*	13	2	9	2	0	0	0	100
3	*Bandisholai*	5	1	0	0	1	0	2	60
4	*Burliyar*	25	9	2	2	2	0	10	60
5	*Yedappalli*	17	5	8	4	0	0	0	100
	Total	91	24	37	13	3	1	12	79
	%	100	26	41	14	3	1	13	87

Thus, the baseline survey highlighted the importance of wetlands along with springs. In order to help the panchayats and communities to manage groundwater sustainably it is important to understand the wetlands and springs together. The panchayats of Hubbathalai, Berhatty and Yedappalli are totally dependent on groundwater to meet their water needs. The survey revealed that while most habitations surveyed across the district in 2001-02 were dependent on springs for their water supply, the proportion had reduced to one-fourth in these panchayats in 2015. Open wells had proliferated and were the main sources of water supply. Most of these open wells were in valleys where small wetlands exist. Except for a few habitations downstream that were dependent on streams for their water supply, all the others were dependent on groundwater.

A detailed baseline survey of water and sanitation was conducted, along with an inventory of all perennial springs in the region. There is a spring density of more than two springs per square kilometre in the Nilgiris region. An interactive spring atlas for the Nigiri Biosphere Reserve with nearly 300 springs is in the public domain at https://nilgiriswaterportal.in.

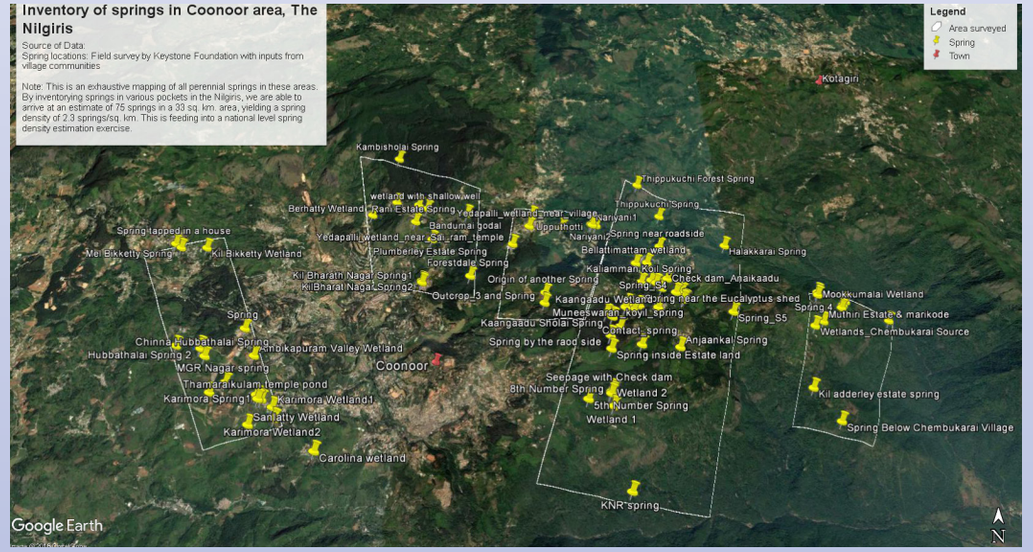


Fig. 8. Estimating Spring Density in the Nilgiris

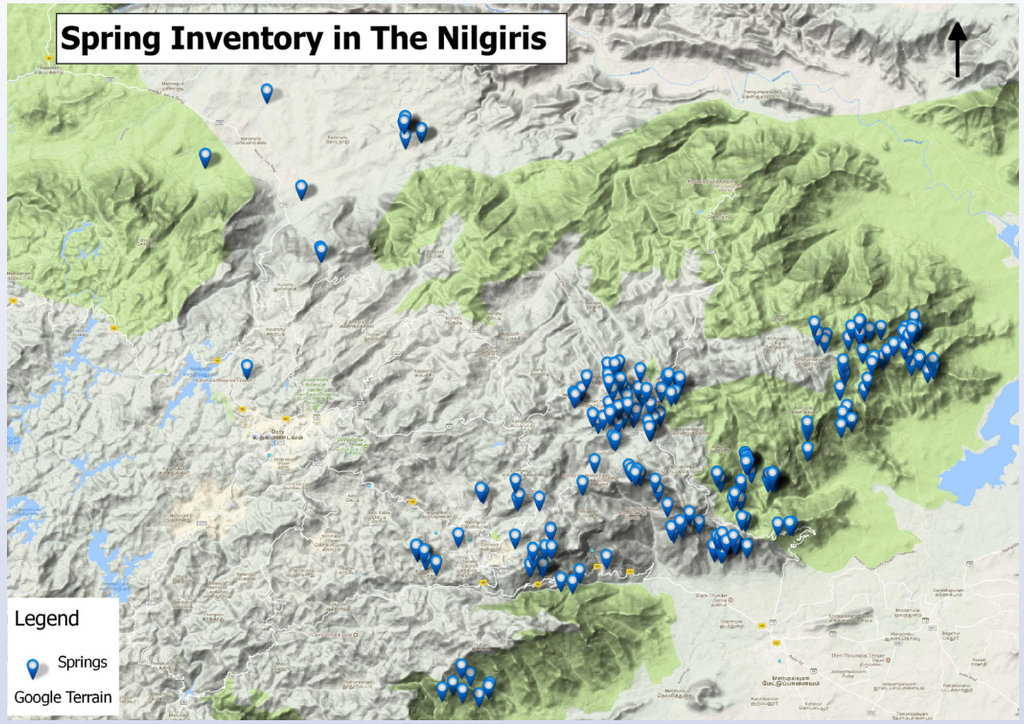


Fig. 9. Spring Inventory

S No.	Location	Area Surveyed (Sq. km)	No. of Springs	Density (Springs/ Sq. km)
1	Aracode 1	8.4	16	1.9
2	Aracode 2	1.0	11	11.0
3	Pillur	11.8	12	1.0
4	Hubbathalai	5.2	11	2.1
5	Berhatty	5.2	11	2.1
6	Yedappalli	3.8	10	2.6
7	Bandisholai-Burliyar	14.9	33	2.2
8	Burliyar	3.8	10	2.6
	Total	54.1	114	2.1

Table 8: Survey of perennial springs in various parts of the NBR by Keystone

An inventory of springs and wetlands was subsequently carried out in Kotagiri town panchayat to expand Keystone's wetland and springshed conservation work in Happy Valley. A subset of springs and open wells across the different locations are now being monitored periodically in terms of discharge/level of water and water quality.

It is important for all the stakeholders, including communities, civil society and government agencies to appreciate the working of springs in the Nilgiris and plan their conservation. Inspiration can be drawn from the traditional practices of communities in the Nilgiris, which include the marking of spring sites as sacred to enforce systems of use, celebrating festivals around springs to reinforce their importance in daily life etc. The Sikkim Government has taken up springshed protection as a major initiative named '*Dhara Vikas*', which is a good example for the Nilgiris as well.

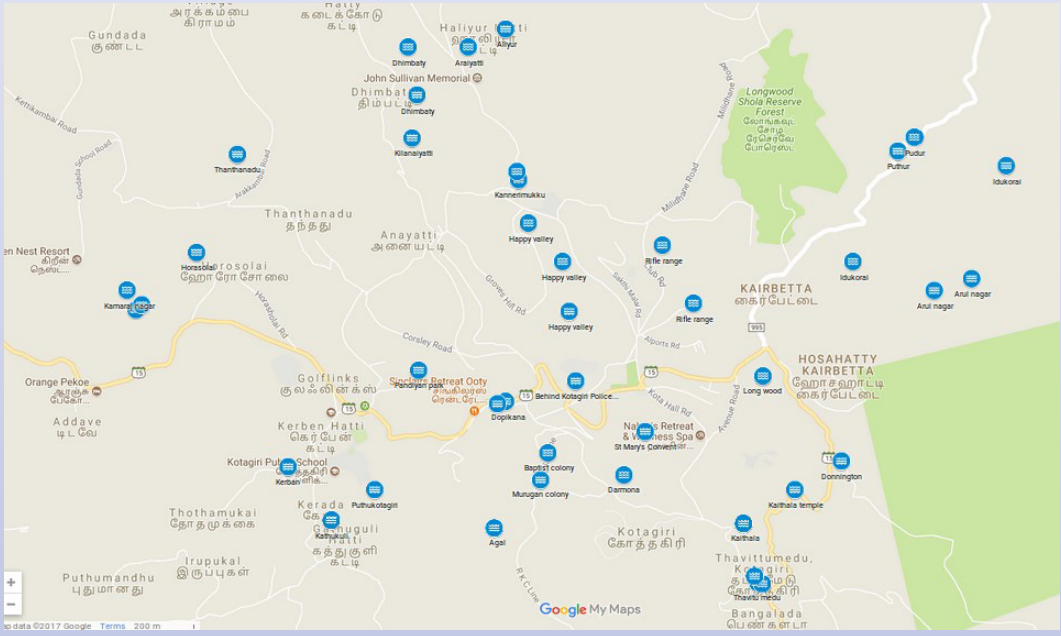


Fig. 10. Inventory of springs in Kotagiri town panchayat – Potential sites for replicating Happy Valley

From Springs to Water Security

As per the CGWB, the Nilgiris district is in a safe zone for groundwater development. This means that the average annual recharge of aquifers due to rainfall far exceeds the annual abstraction of groundwater. However, the rapid acceleration of motorised groundwater pumping, coupled with a lack of regulation means that the situation on the ground is changing rapidly. The monsoon failure in 2012 brought home the water crisis in urban areas in the Nilgiris. In 2016, the region faced its worst monsoon in a long time and there was widespread water crisis across the district. In response to this, Keystone is working with priority habitations in Aracode, Coonoor, Kotagiri, Pillur and Sigur to develop village water security plans that cover aspects such as household water security, water quality, spring protection, springshed and catchment restoration and conservation, providing water resources for wildlife, controlling invasives, sanitation etc. In order to sustain these efforts in the long run Keystone is reinforcing the traditional practices of water conservation on the one hand and liaising with panchayats and line departments on the other.

Keystone expanded the scope to include all its work areas focused on tribal communities and to look at wetlands as well. This created the opportunity to build on the work done over the last two decades and look at water issues holistically. Keystone is also working towards developing models of interventions in different conditions or typologies that could be used as advocacy tools for replication.

Keystone conducted baseline surveys of the water and sanitation situation in tribal habitations in all the areas and chose villages with an immediate need for intervention. Willingness of the

community members in the village to engage with water resource management was also a criterion for selection.

Local youth were trained as Community Resource Persons (CRP) in the area of participatory groundwater management. They started monitoring springs and wells on a monthly basis for both discharge/level of water and quality parameters. Open Data Kit based data collection forms were developed and given to the CRPs on Android tablets for ease of data collection. The CRPs also used simple manual rain gauges to maintain a local rainfall dataset. All these data were shared with the community members on an ongoing basis and the implications of the findings were discussed with them.

Community Resource Persons being trained in spring monitoring

Discussions around developing a Water Security Plan in the village were gradually initiated. The objective was to empower the community with a clear set of interventions to be implemented by the community as well as other agencies to eliminate water stress and deal with other water related issues. In keeping with the ethos of the tribal communities, the plans were not only to meet their own needs but also of the wildlife that lives near their villages. Keystone then helped the selected villages to implement part of their water security plan, with the labour being contributed by the community. This also helped bring the village together in a common activity and developed a sense of ownership in the resource and infrastructure.

One of the hamlets selected was Bangalapadigai, an Irula hamlet in Aracode Panchayat, Kotagiri Taluka. Bangalapadigai has 40 households with a population of about 180. The village has an Anganwadi, a primary school and a value addition centre of the Aadhimalai Pazhangudiyinar Producer Company Limited.

The main sources of water were two springs and an open well. Subsequently, a borewell was dug by the government but it was not operationalised. When discussions began around the water situation, Keystone learnt that the motor in the open well had not been working for more than a year. This was a water source that was shared with the nearby Kokode estate. The well had a perennial water supply and was being used by villages in the region which did not have such plentiful supply.

Within a few feet of the well was the Pulimavakare spring. Legend has it that about three centuries ago, a grandmother and her granddaughter went to fetch water from a pond. They spotted a tiger in the pond. They ran back to their village and told the villagers about it. The villagers rushed to the pond and saw the reflection of the tiger, which was sitting on the branch of a mango tree near the pond. They named the spring Pulimaava baavi (Puli means Tiger). This spring is also known as Olai baavi.

The spring emerged from a hole in the ground at the base of a tree. The area around the spring was a muddy mess as elephants regularly visited the spring to drink water. Close to the well and the spring a concrete slab had been set up for washing clothes.

Spring source being used in Bangalapadigai pre-intervention

Fig. 11. Scenario Pre-intervention

Fig. 12. Scenario Post-intervention

Below this a check dam had been built to provide wildlife with drinking water. However, the path to the check dam was blocked by one of the villagers who was farming close to the check dam. As a result, the elephants started coming regularly to the spring and well during the day and women were forced to wait for them to leave in order to take water to the village or wash clothes. The villagers used the spring water which was being tapped through a pipe stuck at the base of the tree under which the spring was located. The women carried the water on their heads and walked home, a distance of about 200 to 300 m up a slope.

According to the baseline survey, during the monsoon season the average water demand per household was 351 litres per day whereas in summer it dropped to 272 litres per day, in response to reduced availability. However, considering the actual supply of water, there was a shortfall of more than 7,500 litres per day for the village throughout the year. This shortfall was being met by taking the laundry to the well/spring location.

All the households in these villages were accessing the spring water, but there were several problems. Fetching water by headload from the spring in Bangalapadigai led to a conflict with elephants during summer. The well water was dirty due to disuse and the iron content being high. The storage tank was in disrepair and the motor was not working.

The hydrographs of spring discharge and water quality are given below. The planning exercise used these as a basis for initiating the dialogue. There was no issue with respect to TDS or pH. The water was slightly acidic at times.

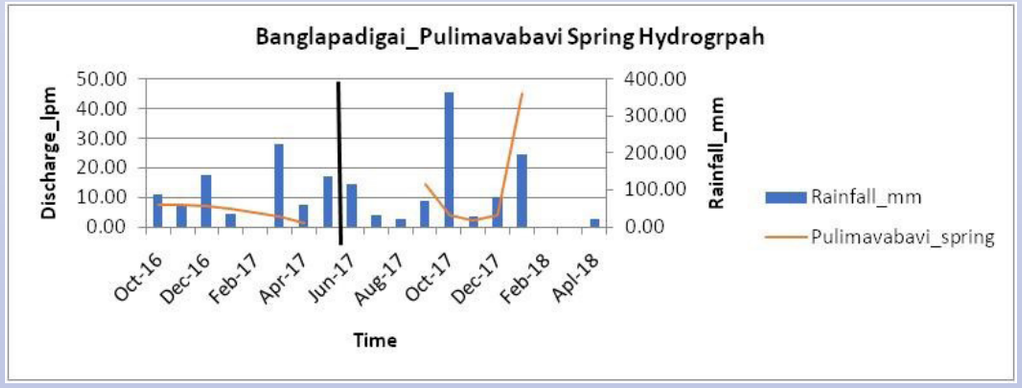


Fig. 13. Spring Discharge (litres per minute) vs Rainfall (mm)

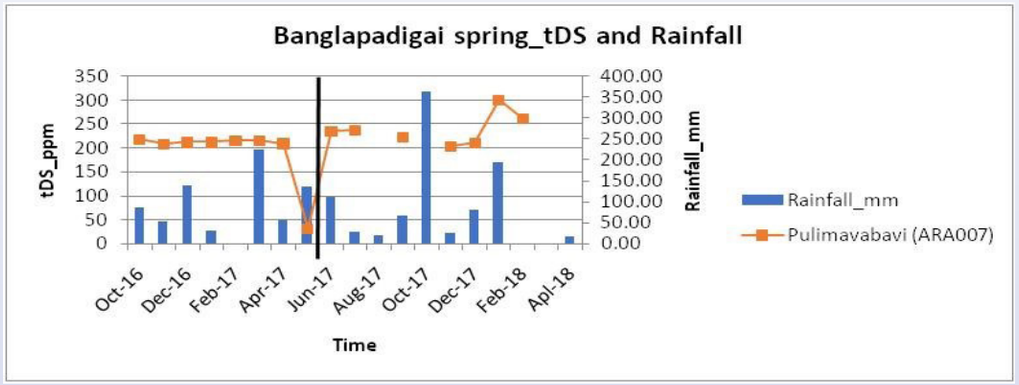


Fig. 14. Total Dissolved Solids (ppm) vs Rainfall (mm)

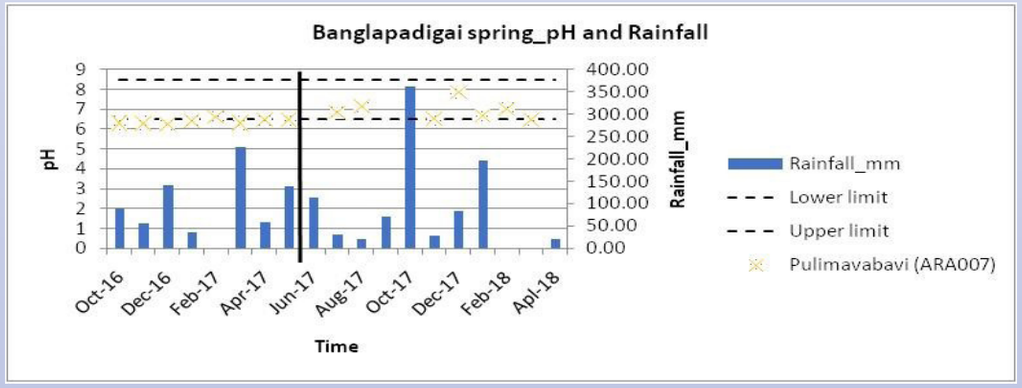


Fig. 15. pH vs Rainfall (mm)

The people had repeatedly asked the panchayat to repair the motor, but they did not help. When the conversation around water management was initiated, the community decided to take matters into its own hands. A group of young people checked the motor and wiring themselves and found that the actual problem was that a section of the wire had been burnt when a farmer set fire to dried biomass over it. They were able to repair this on their own. They also undertook the cleaning of the well, which resulted in the water being potable chemically and biologically.

The community also gathered stones and with support from the springs initiative, constructed a spring box and fenced off the area around the spring to keep the source clean. They set up a new pipe to tap the spring water without contaminating the source. Before this work was taken up, it was imperative that the elephants not be deprived of access to water due to the fencing. Therefore, the path to the check dam was first cleared, the invasive plants in it were removed and common rush, a wetland grass species, was planted to purify the runoff from the clothes washing yard. Thus the water supply was protected and enhanced through restoration efforts in the area around the spring. The wildlife also benefitted from access to a larger water supply.

The open well and the spring tap the same aquifer. With the motor being brought back into action, the storage tank in the village was cleaned up and repaired. The pipeline was refurbished to prevent leakages and contamination of water. The borewell which was put in place in a top down manner, after the process of planning was done, was also connected to the same Ground Level Reservoir (GLR) to ensure better distribution of water to the entire village. Earlier, a 1,000 litre tank placed in the middle of the village had been used for storage with the result that houses in the higher reaches of the village could not get water delivered by gravity. These were the households that had to head-load the water from the spring for the longest distance.

In total, Rs. 7,500 worth of labour was contributed by the community to implement the first phase of the Water Security Plan, assuming one day's wage as Rs. 205 in line with MGNREGA rates in Tamil Nadu. Keystone provided Rs.40,000 towards the cost of material for these activities.

Due to the daily pumping of the open well, it is difficult to ascertain the spring discharge accurately. Given that pumping of the well visibly reduces the spring discharge, the increase in discharge in response to rainfall in the post intervention period is evidence of the impact of the ecorestoration activities close to the spring as well as in the stream banks in the springshed.

Labour contribution by community

Construction of spring box

Case Study of Ambikapuram in Coonoor

Keystone and the faculty and students of the first three batches of the Nilgiris Field Learning Centre at Keystone carried out focused studies on the water and waste linkages in Hubbathalai and Burliar panchayats in Coonoor taluka and the Coonoor town and downstream areas. These studies explored interrelated aspects such as water, waste management, sanitation and health and a case study was developed. A summary of the case study is shared in the following pages. It represents a microcosm of the Nilgiris and many parts of the Western Ghats as well.

Discussing water issues in the gram sabha in Hubbathalai

AMBIKAPURAM VALLEY IN HUBBATHALAI PANCHAYAT

- A Case Study highlighting interlinkages between groundwater, sanitation and other domains

Introduction

Ambikapuram valley is located in Hubbathalai panchayat of Coonoor taluk in the Nilgiris district of Tamil Nadu. The panchayat has 31 habitations with a total population of 10,852. The area has people from Badaga and other communities living in separate habitations. The area was traditionally inhabited by the Badaga community in habitations called *hatties*. Over the last few decades, Tamils from Sri Lanka have been resettled in the area by the government as part of a larger programme. This has led to a number of new habitations being developed in the area with infrastructure such as electricity, houses, roads, schools, drainage systems etc.

These growing settlements are located close to each other with tea plantations around them. The panchayat is adjacent to the Coonoor municipality area and can be characterised as peri-urban. This is reflected in the fact that only 9 % of the total workers in the panchayat are involved in agriculture and allied activities. In general, land ownership is common in the Badaga settlements and less common in the other habitations. When they were resettled here, most of the Tamils worked in the tea plantations of the Badagas. Over the decades their livelihoods have diversified to include many non-farm activities, although daily wage work is still an important source of income.

The case study focuses on a smaller area within the panchayat that is typical of any other part of the Nilgiris. This area has been defined as the watershed of the drainage that flows out of the Ambikapuram valley habitation (See Fig. 16). Most of the water sources of these habitations are located in this valley. The total area of the watershed is approximately 238 acres.

The area pertains to the following habitations:

1. Ambikapuram
2. Chinna Hubbathalai
3. Halorai
4. Indira Nagar
5. Kakkan Nagar
6. Kurinji Nagar
7. MGR Nagar
8. Narikulipallam
9. Pazhathottam
10. Gandhi Nagar
11. Jevana Gowder Line

In addition, the government school in Hubbathalai also draws water from a well in this valley.

Water Supply and Sanitation Situation in the Area in 2015

These communities receive water through springs and/or open wells located in the Ambikapuram valley. MGR Nagar also gets water from an open well and spring outside this catchment. The situation as captured in our baseline survey in 2015 is given below.

In 2015, open defecation was reported to varying degrees in Pazhathottam, Kurinji Nagar, MGR Nagar, Indira Nagar and Gandhi Nagar. Only in Chinna Hubbathalai and Jevana Gowder Line was the community toilet being used. In MGR Nagar it had been unused for a few years since the women's group in charge of maintaining it had handed it back to the panchayat. Subsequently, this toilet was revived by the panchayat alongside

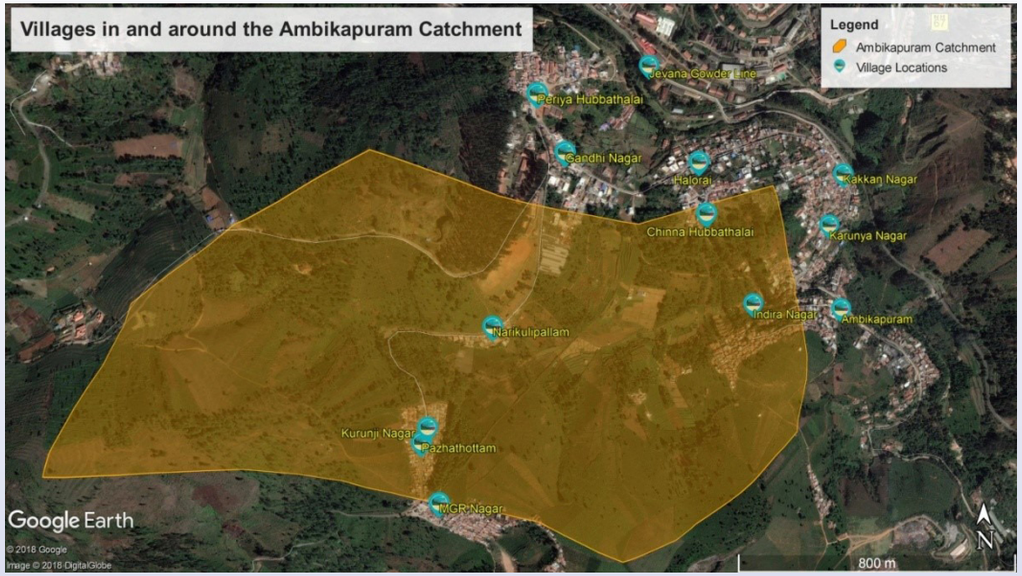


Fig. 16. Context map of Ambikapuram Valley

S No.	Habitation Name	Sources	Source Type(s)	Supply	Issues reported in surveys
1	Ambikapuram	Ambikapuram valley – 2 wells	Well	Daily supply for some households. Once in 2-4 days for some depending on the season. Well water alternate days 0.5-1 hr.	Reduced supply in summer. Muddy water
2	Chinna Hubbathalai	Sengarani Thottam Ambikapuram Valley	Spring Well	24/7 2 hrs a day daily	Muddy water from well.
3	Halorai	Sengarani Thottam – overflow	Spring	1.5-2.5 hrs a day throughout the year	-
4	Indira Nagar	Ambikapuram Valley	Well	3 hrs every two days throughout the year.	Muddy water
5	Kakkan Nagar	Narikulipallam Spring Ambikapuram valley	Spring Well	Min. 1 hr a day throughout the year	Reduced supply in summer. Oily film in well water due to Iron.
6	Kurinji Nagar	Narikulipallam Spring	Spring	2 hrs a day throughout the year	-
7	MGR Nagar	MGR Nagar Spring Bengalmattam well Ambikapuram Valley	Spring Well Well	Alternate days throughout the year	Insufficient supply in Summer.
8	Narikkulipallam	Narikulipallam Spring	Spring	1.5- hrs for most households; 15-30 minutes per day for a few of the families.	Insufficient water supply.
9	Pazhathottam	Narikulipallam	Spring	Alternate days in summer; 24/7 remaining seasons.	Pipes get blocked during monsoon season. Muddy water during rains. Oily water.
10	Gandhi Nagar	Gandhi Nagar Jevana Gowder Line Pororai	Well Well Well	1.5 hrs a day throughout the year	Muddy water during rain, drainage mixed
11	Jevana Gowder Line	Jevana Gowder Line	Well	24/7 throughout the year	Some households report alternate day supply

Table 9: Summary of water supply situation in Ambikapuram Valley

Keystone's intervention of building a spring box and setting up a water supply system based on it. It was initially planned that the overflow water from this spring would feed the toilet. But the spring flow diminished considerably since the box was constructed, due to lack of sufficient rainfall. Therefore the pipeline was not laid. In the other habitations, there were no community toilets.

Land Use

The analysis of land use changes in the region over a period of five years shows that there is a trend towards conversion of farmland - be it vegetable farms or tea plantations - to built-up area. This is evident from the hectic construction activity in these habitations as well. The graph below (Fig. 17) shows the quantum of these changes.

The overall increase in built-up area (habitation) is about 1.25 acres, which is at the cost of tea and vegetable farming. In the coming years, this trend will only intensify as tea is an ailing industry and real estate is going through a boom. The proximity of this area to Coonoor town is a major factor in this development. The increase in built-up area brings with it an increase in demand for water. In about 0.1 acres of land above the depression spring in Sengarani thottam area, the community has undertaken fencing of the land and restoration activities to conserve the spring and ensure that it provides good water flows in the future. This piece of land is a small island in a catchment full of tea plantations owned by community members.

Land Use Change in the Valley

The hill tops and slopes right down to the valley are covered by tea plantations belonging to local Badaga families. A portion of the valley has vegetable farms. It is a common practice in this region to use chemical fertilizers, pesticides and herbicides in these fields. These leach into the ground. The sewage from some habitations is let out into the tea plantations which are part of this catchment. In some habitations, open defecation is still the norm. Grazing

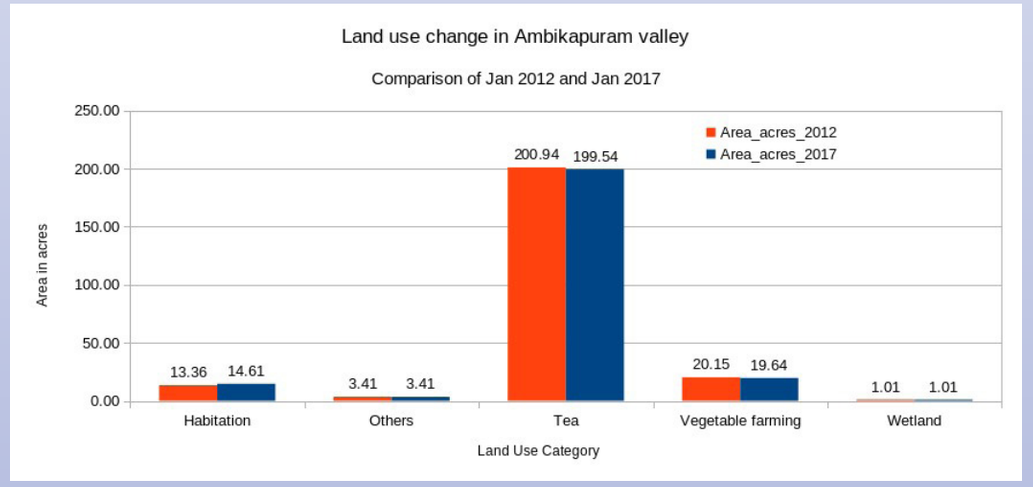


Fig. 17. Land use change in Ambikapuram Valley from 2012-2017

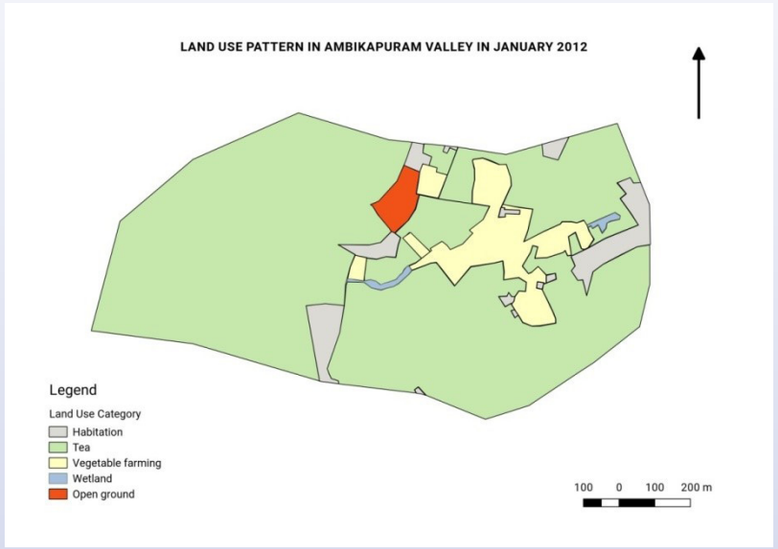


Fig. 18. Land use/cover in 2012

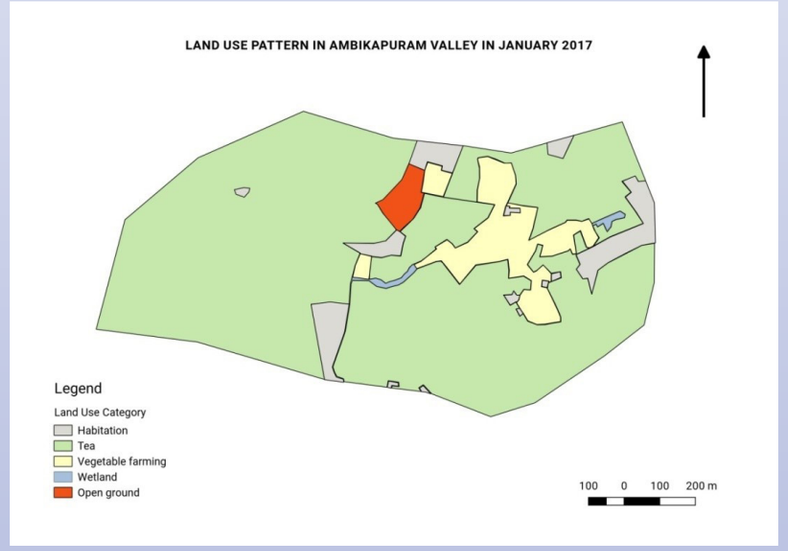


Fig. 19. Land use/cover in 2017

animals like domestic goats and cattle and wild gaur also add to the faecal matter in the catchments. Where toilets have been built and are being used, the tanks are single leach pit models, which let the septic waste seep into the ground, with possibility of contaminating the groundwater. The testing of a sample of open wells in the valley has shown that faecal coliform is present in the water.

The massive storage tank inside the Ambikapuram valley catchment is also an important source of drinking water for the Coonoor Municipality area. The water passes through three levels of filtration tanks before it enters the pipeline for distribution. The tank water has not been tested, but an accumulation of silt is visible in the tank. This has increased due to intensive vegetable cultivation in the catchment leading to high run-off of soil and other chemicals after each harvest. The water in the tank tested positive for coliform. The stream is treated as a waste carrier once it enters the Ambikapuram town. Sewage from households is let out directly into the stream which flows down to join the Coonoor river. The coliform in the storage tank tested positive.

Geology of Ambikapuram valley

Near the Hubbathalai springs the rocks are mostly exposed. Towards the outlet of the valley there is a thick layer of sediments and weathered rock. The whole valley has a single type of rock, which is Charnockite. Near a quarry outside the valley there are north-south trending vertical fractures. The foliation of the rock is the same as in the other two catchments. The thickness of sediments and weathered rock along the valley seems to be more than 9 meters (based on well depths). The thickness of this layer gradually decreases towards the hill tops. Sediments and weathered rock are primarily composed of clay.

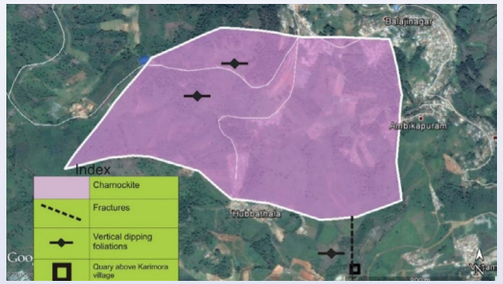


Fig. 20. Geology of Ambikapuram Valley

Hydrogeology of Ambikapuram Valley

Ambikapuram is an east-west trending valley. The elevation in the valley ranges from 1,988 m – 1,877 m. It has gentle slopes and greater thickness of sediments and weathered material. This unconsolidated material forms the unconfined aquifer in this valley. The depths of wells indicate that the thickness of the aquifer is greater than 10 metres. Two springs (Hubbathalai springs) have been identified in the valley. These springs, which are depression type springs, are the major source of water for the valley. They are very old springs and have a very high discharge. Rocky outcrops are hardly seen in the valley except in a quarry to the south of the valley. The major vertical fractures are north-south trending.

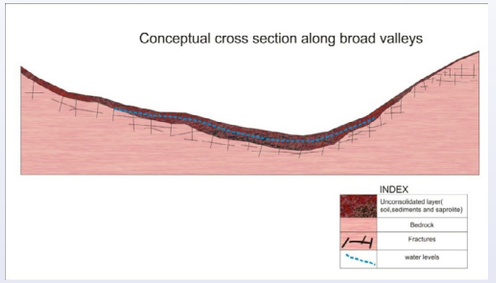


Fig. 21. Cross section along the gentle slope gradient

Hubbathalai spring

The entire spring shed of the Hubbathalai spring system comprises soil, unconsolidated debris and weathered and hard-compact Quartzite/Charnockite. The soil layer is relatively thinner at higher elevations than in the valley. Underlying the soil is unconsolidated debris which comprises rolled and deposited rock material of varying sizes. There are also huge boulders of Quartzite in the valley. The debris deposit is thick in the central part of the valley and relatively thinner up on the flanks. There are massive deposits of Quartzite/Charnockite at the base. The rock is hard and compact and exposed on the surface in the northern part of the ridge. The Quartzites/ Charnockites are exposed only at one or two locations. It is therefore difficult to map out the spread of their extent, vertically and laterally (Fig. 22).

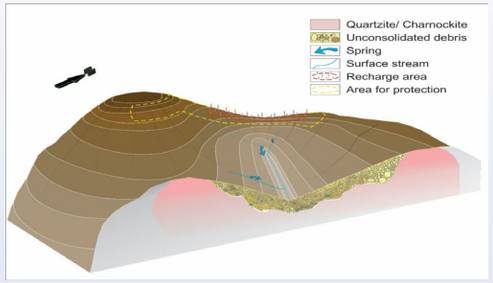


Fig. 22. Conceptual hydrogeological diagram of Hubbathalai spring

Recharge areas

Hubbathalai springs are the main natural discharge points in Ambikapuram valley. Recharge and protection areas demarcated for these springs comprise mainly the private tea plantations. The hill tops all along the valley form the recharge areas for the aquifer in the valley.

Fig. 23. Recharge area of Hubbathalai springs

Spring Discharge

There are two main springs in the upper area of the catchment - Sengarani thottam spring and Narukulipallam spring. These are already being tapped by five habitations and the water is being supplied to Ground Level Reservoirs (GLRs) there. Given the high pressure on water resources there and the occasional disputes between villages over water sharing, the villages are reluctant to set up T-junctions at the source. Therefore,

Keystone set up T-junctions in each habitation. However, over the last three years the pipelines in these villages have been frequently repaired, leading to disruption in measurements. The result is that reliable spring discharge data for the area are not available.

The water quality data indicates the constant presence of faecal coliform, very low Total Dissolved Solids (TDS) of below 60 ppm and pH within the acceptable range. Villages like Chinna Hubbathalai, Aalorai and Pazhathottam escape the chemical and geogenic pollution from the well water as it is not used for drinking; it is used only for other purposes.

Well Dynamic Data Analysis

In order to understand the dynamics of groundwater in the valley, the depth to water level in open wells, along with the water quality was measured every month. The rainfall was also recorded on a daily basis at Ralliah Dam using an automated rain gauge. The reduced water level was normalised with respect to sea level and this was plotted against rainfall to compare the status of wells across the topography. The depth to water level was also plotted against rainfall to understand the extent of fluctuation in a well compared to the others.

Analysis of these graphs showed that Ambikapuram (HUBW001), Kakkan Nagar (HUBW003) and, to some extent, Pazhathottam and MGR Nagar (HUBW009) wells experienced a high level of fluctuation, whereas the Kil Ambikapuram (HUBW002), Indira Nagar (HUBW004), Hubbathalai government school (HUBW005) and a private irrigation well (HUBW006) showed moderate fluctuation. Two irrigation wells (HUBW007 and HUBW008) and an unused private well (HUBW010) showed low levels of fluctuation in water levels.

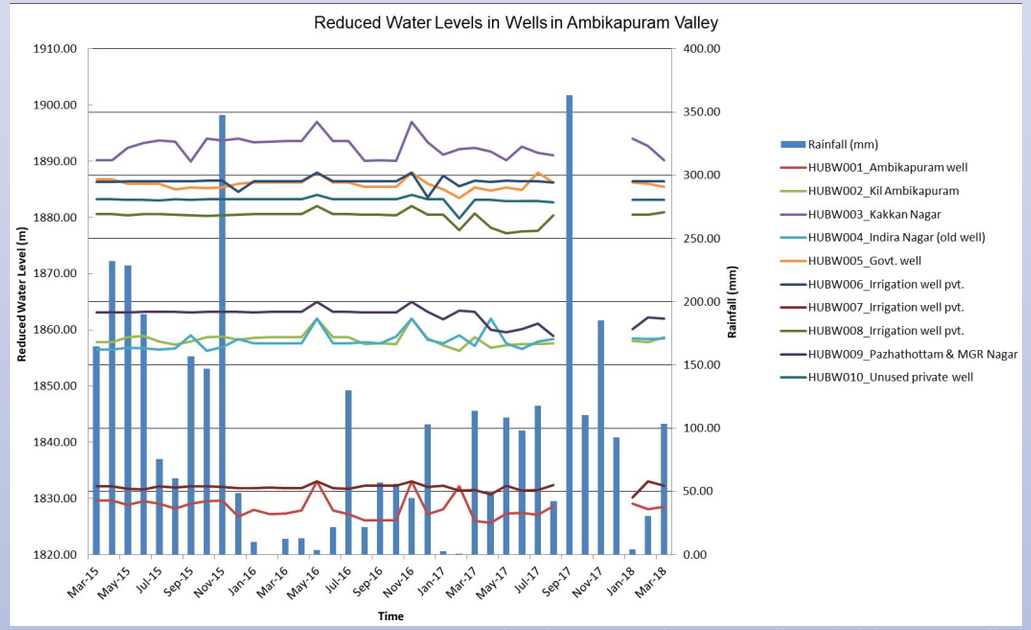


Fig. 24. Reduced Water Level in open wells in Ambikapuram Valley

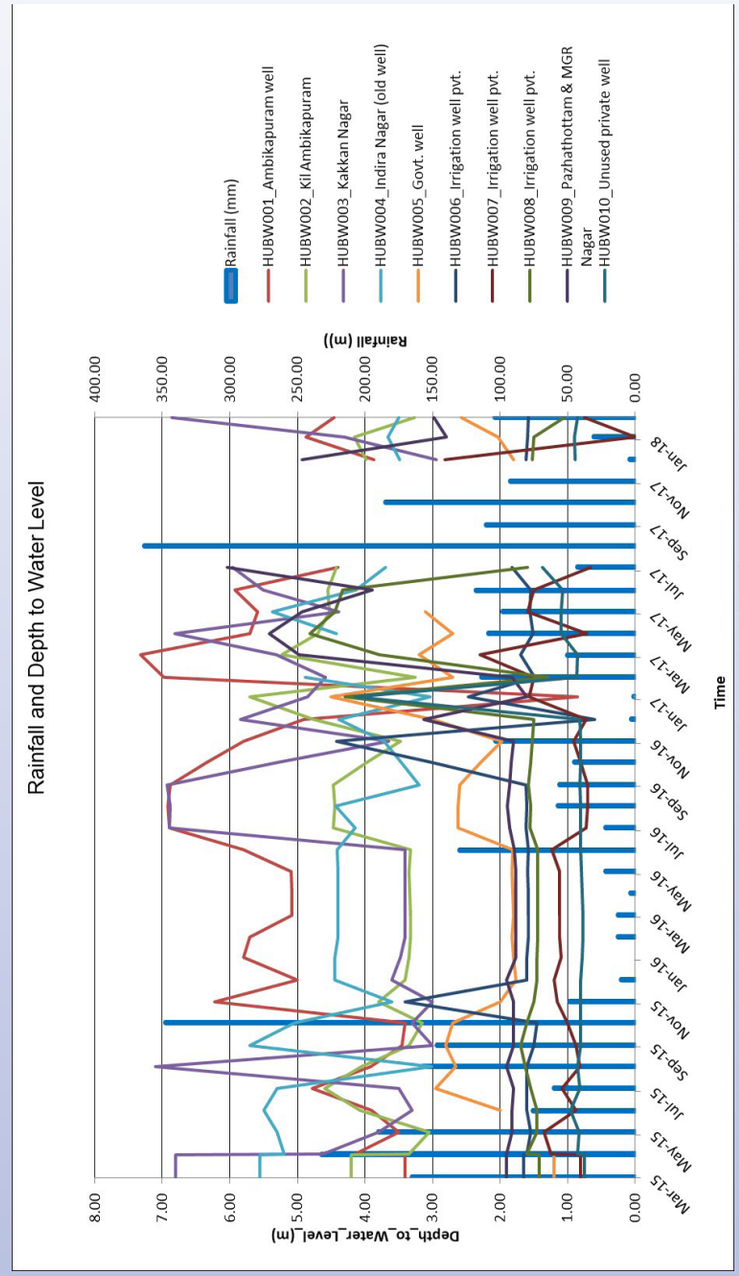


Fig. 25. Depth to Water Level in open wells in Ambikapuram Valley

From the level of fluctuation of water levels, Keystone inferred that the wells HUBW001 to HUBW006 were in the recharge zone, whereas wells HUBW007 to HUBW010 were in the discharge zone. However it must be remembered that the wells were being pumped out almost daily and this could have affected the readings of water levels.

In terms of water quality, there were seasonal fluctuations in all the wells with regard to pH, although nearly all the wells had acidic water at times. This was to be expected, given the lateritic soils in the catchment. TDS was not a matter of concern in the region as the level was never over 200 ppm. Faecal coliform was present across all the wells during most of the year.

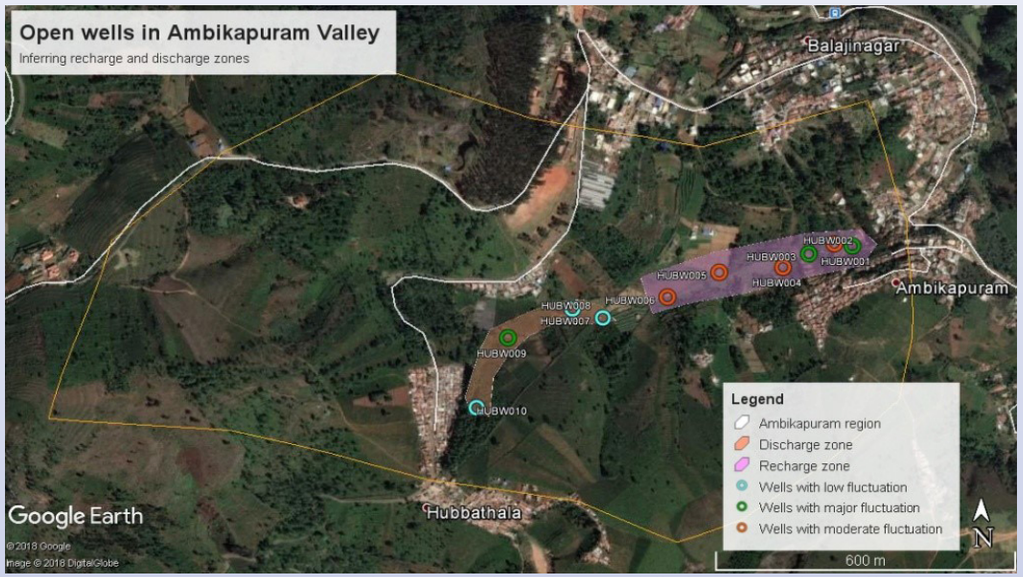


Fig. 26. Potential recharge and discharge areas in Ambikapuram valley

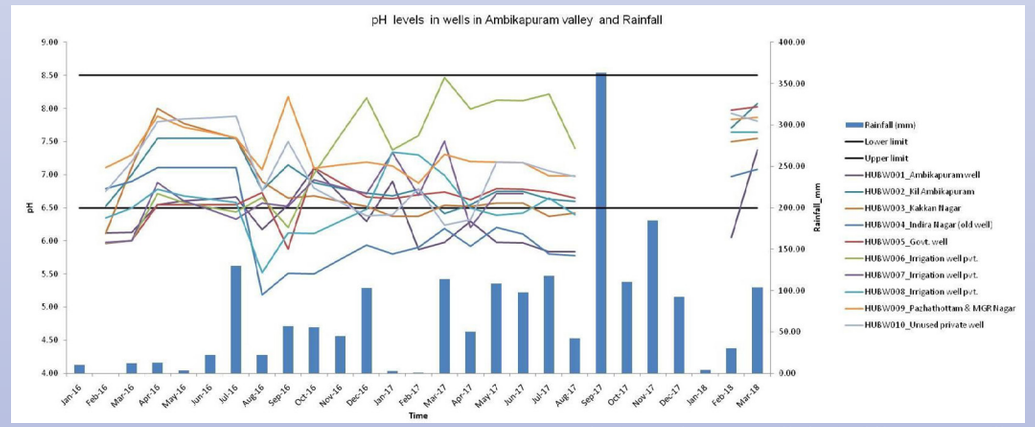


Fig. 27. pH in open wells in Ambikapuram valley

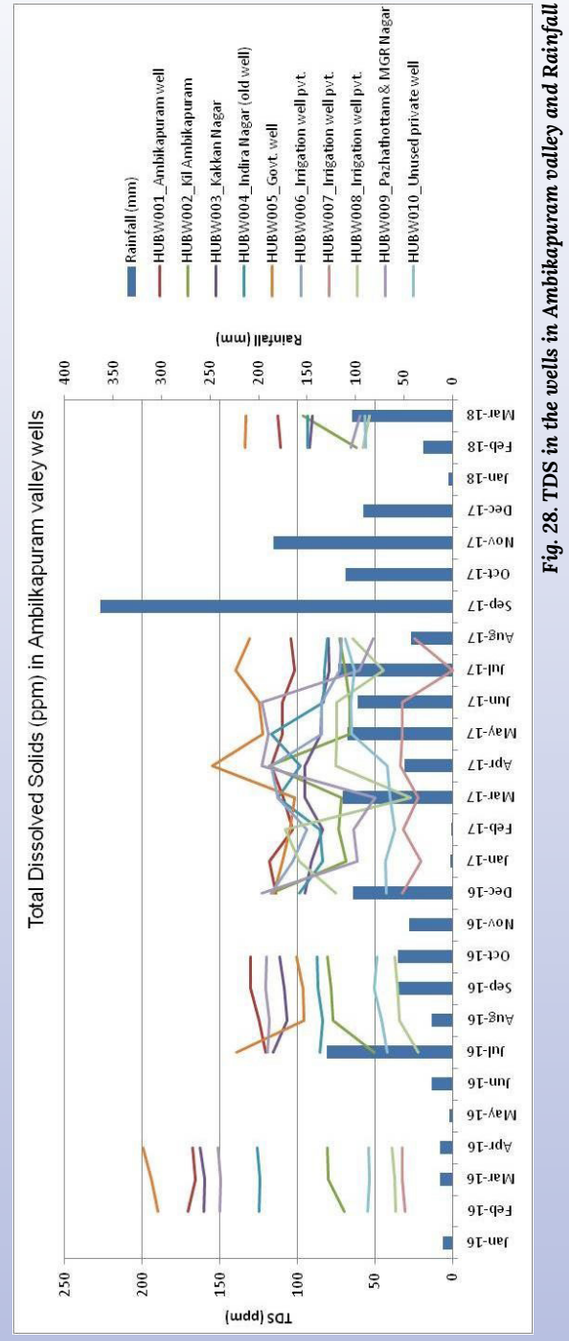


Fig. 28. TDS in the wells in Ambikapuram valley and Rainfall

S No.	Well	Coliform	Ammonia	Phosphate	Iron
1	Chinna Hubbathalai	2015, 2016	2015, 2016	2015, 2016	-
2	Kil Ambikapuram	2015	-	2015, 2016	-
3	Kakkan Nagar	2016, 2018	2015, 2016, 2018	2015, 2016, 2018	2018
4	Indira Nagar	-	2015	2015, 2016	2015
5	Ambikapuram	-	-	2015, 2016	-
6	Pazhathottam and MGR Nagar	2018	2018	2016, 2018	2018
7	MGR Nagar	-	-	2015, 2016	-
8	Hubbathalai School	2015, 2016, 2018	2015, 2016, 2018	2015, 2016, 2018	-
9	Jevana Gowder Line	2015, 2018	2015, 2018	2015, 2016, 2018	2018
10	Narikulipallam	2015	2016	2015, 2016	-

Table 10: Water Quality Issues detected in Panchayat Drinking water wells

Note: Samples were taken on 2 June 2015, 3 August 2016 and 7 March 2018 and analysed in the TWAD Laboratory, Ooty. On 29 March 2017, samples were tested using the portable water testing kit, Jal Tara, at Keystone.

Given that all these wells are in one valley, there is an obvious impact of sanitation practices, waste management and chemical input-based farming on the water quality. While the levels may vary from well to well due to various factors, the above issues need to be addressed in all the upstream villages in order to safeguard the water quality. Routine maintenance of wells is also important to improve the water quality.

Waste Management

The baseline survey in the panchayat in 2015, revealed that the only waste management set up in the panchayat consisted of waste bins in five habitations, of which only a few were cleared by the pickup service of the panchayat. Waste disposal was mostly done by the households themselves, usually close to their houses, with burning being the only strategy to clear the accumulated waste. Private recyclers from Coonoor visit the villages regularly to pick up salvageable solid waste that makes its way to Coimbatore eventually through a multi-stage complex network of waste collectors, segregators and processors (NFLC Water and Waste Study 2017). Much of the waste was also dumped close to natural drains where it is transported downstream to the Coonoor river when it rains.

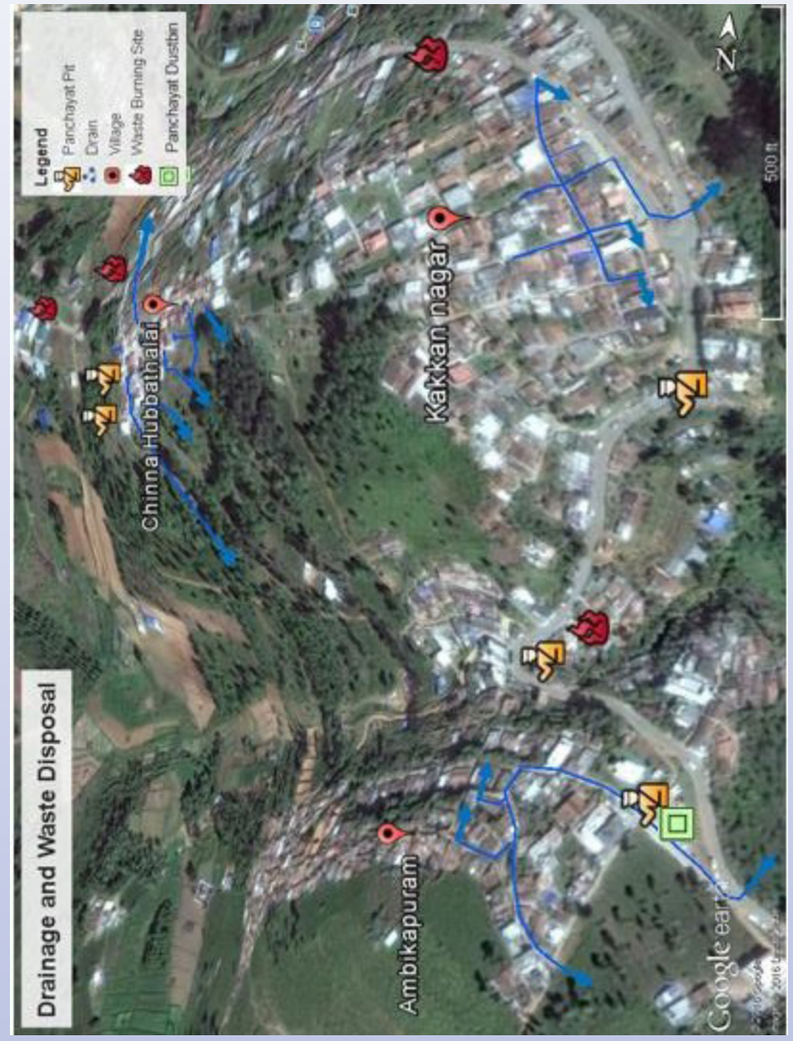


Fig. 29. Waste disposal in Ambikapuram valley (NFLC 2016 Research Report)

Sewage was typically channelled into drains within the habitations, but more often it was let out into the tea plantations close to the habitations. This system of disposal drained the sewage towards the valleys where the wells were located. The presence of ammonia above the prescribed limits in samples from seven out of the ten wells sampled indicated that the sewage was finding its way into the aquifer and from there to the wells.

In 2016, a sample survey of people from Chinna Hubbathalai, Ambikapuram and Kakkan Nagar revealed that 90 % of respondents did not think that their waste disposal affected their water quality in any way. This might explain the common practice of dumping waste near drains where rainwater run-off easily carried it away downstream.

Since 2016-17, the MGNREGA has been leveraged to support waste collection in the villages. In the 32 areas of the panchayat, there were 27 workers and several supervisors. *Thooymai Kaavalars* collect and segregate the waste from at least ten houses each day. One *Thooymai Kaavalar* covers one habitation, but in densely populated areas there is usually some type of work sharing to avoid overloading any individual *Thooymai Kaavalar*. For example, in four habitations that are close to each other, there are over 1000 households, three collectors and one supervisor. In another area, where there are three habitations and fewer households, there are three collectors, and one supervisor. The workers usually serve their own area, though they might sometimes go to the neighbouring habitation to work. The collectors and supervisors are always women[15]. There are several issues with this arrangement. The workers work throughout the year, but use other people's job cards, since they can use their own card for only 100 days in a year. Sometimes they have to pay a commission to the card-owner to retrieve their wages. This informal arrangement seems to have the tacit approval of the administration as it seems to have been systematized. While it is important to take care of the waste, the rights of the workers should not be neglected either.

Initially, there were pits dug on the outskirts of every village, for the segregated waste to be dumped. The biodegradable waste was supposed to be composted on site and the plastics and other waste was to be transported to a recycling unit. However, in most cases, only the waste that had re-sale value was collected by the authorities. The rest was burnt in the pits, defeating the very purpose of the programme. The scheme was changed recently. Now only non-biodegradable waste is collected from the households who are expected to dump the compostable waste in the common compost pit themselves or compost it at the household level.

Sanitation

Most of the area has toilets, although in the newer Tamil settlements there are often multiple reasons for the lack of toilets in households. When the government houses were built they did not have any provision for a toilet. Thus, in some cases there is no space near the house to build a toilet under the Swachh Bharat Scheme. In some instances, there is no revetment below the house, without which the construction of a toilet is not feasible. There are two community toilets in MGR Nagar and Narikulipallam respectively. Both were not being used. However, the one in MGR Nagar, which is meant only for women, was revived by the panchayat when Keystone helped the community build a spring box and set up a pipeline and storage system for that water.

Open defecation is the norm in the region, with the tea plantations around the habitation being the main sites for OD. As a result both the well water and spring water show the presence of faecal coliform from time to time. For various reasons, the people do not necessarily boil the water for drinking. The water in the Ground Level Reservoir (GLR) is chlorinated only once in two weeks and its effectiveness is questionable. People report the incidence of water-borne diseases, especially during the monsoon. Thus, there is a need to raise awareness regarding water, sanitation and hygiene.

Where toilets are being built and used, the design is faulty. Soak pits are preferred to septic tanks to contain the waste as families do not want the hassle of emptying the tanks once every few years. The bottom of the pits are unlined and waste water is able to seep through to the groundwater. Unlike plains areas there is added difficulty due to the terrain and slope and the availability of roads inside the habitations. Thus, depending on the distance and nature of the soil, the sanitation waste may not have enough time in the soil to be purified. This is another possible source of contamination.

In 2017, observation of a few families using the Baby WASH protocol showed that the typical family is not diligent about hand washing and babies are exposed to faecal matter through several sources in and around the house[16]. Thus, focusing only on using toilets is not enough. A holistic intervention that changes WASH related behaviour is needed. In this the cultural differences among different communities has to be factored in.

Conclusion

In a small area such as the Ambikapuram valley, one can observe the dynamics related to land-water-waste in detail. The nature of changes to the landscape and the increasing demand for water are putting immense pressure on the limited resources. Solid and liquid waste and sanitation are important drivers in determining water quality. Traditional beliefs such as 'spring water is pure' are belied by the results of coliform tests as the springsheds are used for OD or are increasingly being converted to habitations. It is therefore necessary not only to monitor and conserve water sources but also to work on the conservation of catchment/springshed areas. The complex challenges facing the Nilgiris today can be tackled by integrating land, water and waste management, balancing the needs of the people (development) and nature (ecology), i.e., through an eco-development approach.

15 NFLC Water and Waste Research Study Report 2017.

16 Ibid

SURFACE WATER

Rivers, Streams and Reservoirs

As work began on this book, the state of Kerala was reeling under floods caused by unprecedented rains. The blame game went on between neighbouring states over the release of dam water, between environmentalists and the pro-development lobby over destruction of forests and rivers, between the State and Centre over aid and so on. Dr Madhav Gadgil is an eminent ecologist who led the Western Ghats Ecology Expert Panel (WGEEP) that recommended the declaration of Ecologically Sensitive Areas (ESA) in the Western Ghats, including parts of Kerala. He stated that the floods are a '(hu)man-made calamity. The State Government of Kerala had rejected the recommendations of the committee which suggested putting restrictions on mining and quarrying, diversion of forest land for non-forest purposes and building of high rises in some places. According to Prof Gadgil, the lack of effort to safeguard the ecology of this region led to the severe damage to life and property caused by the unusually high rainfall in August 2018[17].

In the Nilgiris, Coonoor witnessed flooding in 2015 due to heavy overnight rain that washed away trees and other debris and blocked a stream[18]. The encroachment on stream banks and the reduction of the actual stream width over time, makes heavy rainfall events a potential source of flooding as the intensity of rainfall is higher nowadays than it was a few decades ago[19].

17 https://www.indiatoday.in/kerala-floods/story/kerala-floods-is-man-made-calamity-madhav-gadgil-1316713-2018-08-17

18 https://www.thehindu.com/news/national/tamil-nadu/flash-flood-washes-away-vehicles-in-coonoor/article6971707.ece

19 http://www.ciesin.org/docs/002-159/002-159.html

More than the rainfall, the way the landscape is being managed is a factor leading to these calamities.

Stream in Sigur

Historically, the Nilgiris has been a major contributor to electricity generation in Tamil Nadu. This was the result of the large-scale construction of dams and a network of tunnels to divert large quantities of water. This resulted in the reduction of downstream water flows and all other river water uses being subordinated to electricity generation.

While working in the Sigur plateau, Keystone found that the drying up of the Sigur river in summer led to wells drying and a scarcity of water in the region for both people and wildlife. In February 2018, due to the widespread scarcity of water and fodder in the plateau, water from the Kamaraj dam was released[20]. There was an immediate improvement in the water situation as tribal communities close to the streams were able to tap water from their drinking water wells and wildlife could access water directly from the stream.

20 https://www.thehindu.com/news/cities/Coimbatore/water-from-kamaraj-sagar-dam-released-into-sigur-plateau/article22874906.ece

The dams have artificially changed the flow patterns of rivers and streams and have created local surpluses and scarcities. Local communities have had to sacrifice access to water so that 'greater' objectives such as power generation, irrigation etc. could be met. Hill communities are deprived of water and cannot provide even protective irrigation for their rainfed crops, but the water stored upstream in hydroelectric dams or downstream in the Bhavani Sagar or Pillur dams are used for other purposes. Tribal habitations in the region may be located close to a dam but face water scarcity during summer. To compound this situation, private tea and coffee estates also divert stream water to check dams on their land and privatise the common water resource. The failure of the monsoon over the last few years has prompted a gradual increase in the practice of irrigating tea plantations. Earlier, perennial springs were tapped to irrigate by gravity, but now the pumping of water is not uncommon. This deprives communities who live nearby and downstream, of water flows in summer. It is difficult for any habitation to challenge a large estate for its share of water, especially when many of the inhabitants depend on the latter for employment. This unequal power relationship exists between estates and (mostly tribal) habitations in the upper Nilgiris and between private resorts and tribal habitations in the Sigur plateau. Since water is one of the services provided by the panchayats, these institutions can bring to bear undue influence and leverage resources. It is ironic that the estates that privatise common property water resources so freely are reluctant to allow road access to small habitations located close to them, in violation of easement laws.

Sigur Plateau

The Sigur plateau is different from the rest of the Nilgiris district in terms of climate and topography. Here it is possible to examine the downstream impacts of the water resource development undertaken in the Upper Nilgiris.

Thus, following the work on Hill Waters and Livelihoods, Keystone decided to focus on the Sigur plateau. Keystone partnered with hydrogeologists to undertake a water resources audit of the plateau to support appropriate water resource management interventions. To develop a strategy for Community-based Sustainable Interventions through Action Research, Innovation and Enterprise for the Conservation and Development of Freshwater Resources.

Context

The Sigur plateau is the northern portion of the Nilgiris district, with Kerala to the west and Karnataka to the north. The Sigur plateau is separated from the Mysore plateau by the Moyar gorge. The Nilgiris plateau is to the south of the Sigur plateau. The average elevation of the Plateau is 900m AMSL.

The main rivers in the Sigur plateau are the Moyar river, the Sigur river, the Avarahalla river, the Kedarhalla river, and the Gundattihalla river. These are fed by rivers in the Nilgiris plateau, namely the Bhavani, Kundah, Hadathoraihalla, Kukalthoraihalla, Sigur, Pykara, and other minor rivers, some of which have been dammed for the last five decades. *All the rivers and their tributaries that originate from the Nilgiris plateau were once perennial; the water regimes modified for purposes of power generation and irrigation have rendered some of these rivers seasonal and many water courses have also been altered by new canal systems*[21].The majority of the area is undulating with the land sloping from west to east with a slight tilt towards the north.

Moyar River

Annual Rainfall in the plateau varies from around 500 mm in the west to about 1,000 mm in the east. This translates to a diverse vegetation pattern, with dry deciduous forests in the west and more scrub jungle (*Pankadu*) to the east. Throughout the plateau, dense riparian forests are found along the riverbanks. The scrub vegetation makes it suitable for pastoralism and the region has a long history of open grazing by people from the Nilgiris and the plains.

The area has a tribal population composed mainly of Kasavas, Irulas, Jenukurumbas and Sholigas. Non-tribals are also present in significant numbers due to the commercial opportunities presented along the Bangalore-Ooty road and also the tourist resorts in the Plateau. The tribal villages in the region are part of different panchayats that include villages in the Nilgiris plateau. They are thus marginalised by the non-tribal population that dominates these institutions and their geographic remoteness adds to their lack of development. The tribal villages inside the forests are also poorly developed in terms of infrastructure and bear the brunt of increased human-wildlife conflict.

21 Keystone Foundation. Report of the Sigur Water Resources Project. 2007

Scrub Jungle in Moyar

Much of the plateau, being a part of the Mudumalai Tiger Reserve, is now under the strict enforcement of forest protection laws. The plateau is a corridor for the migration of the Indian elephant. The large-scale cattle rearing that was once prominent here is on the decline. Farming is also declining due to the lack of water for irrigation. This is due to monsoon failures and also the diversion of river water for power generation.

Biotite hornblende gneiss - the most common rock type

The most commonly occurring soils are light yellow to reddish brown clay soils. Humus soil of about 0.5 m thickness is confined to the areas covered by thick vegetation. Regarding fertility, the soils are generally deficient in plant nutrients and are acidic with pH values of 4.6 to 6.1. These soils contain a large percentage of alumina and iron, which restrict the availability of phosphates to plants. Nutrient content studies show that the soils are rich in nitrogen and potash and low in phosphorus. The depth of the topsoil varies from 0 to 45 cm, on an average and that of the sub-soil from 3 to 4.5 m[22].

The rock base throughout the Nilgiris is fairly homogenous and impermeable and this is reflected in the uniform drainage density. However, there are considerable spatial and temporal differences in the stream flow, or runoff. With the absence of aquifers such as sandstone or calcareous formations, the runoff mainly represents that of 'surface' and 'base runoff' of water that has infiltrated the soil and is released after a more-or-less extensive time-lag, depending on the slope and water retention capacity of the soil. Deep percolation and groundwater runoff are negligible in the Nilgiris. Therefore, annual runoff amounts, and runoff regimens are highly correlated to annual rainfall and rainfall patterns. Hydrological data from the Mysore plateau below the Sigur plateau indicate that average runoff /rainfall ratios may even drop to 15 % and individual figures suggest that in some years these areas do not contribute to the stream flow of the Moyar at all[23].

The major water sources in the plateau are springs, dug wells, bore wells and check dams. Spring density in the plateau is very low compared to the upper Nilgiris, although there are a few perennial springs.

A study of the sections of dug wells indicates that the soil thickness and

22 Keystone Foundation. Report of the Sigur Water Resources Project. 2007

23 Ibid

Spring emerging from rock at Anaikatty

intensity of fracturing vary considerably across the Sigur plateau. The proliferation of borewells in the region has also affected the water levels in the dug wells. Dug wells close to the rivers are used by the communities as sources of drinking water. However, the lack of year-round flow in the rivers results in the drying up of these wells in summer.

Check dams were built in the early 1990s to enable the communities and wildlife to access river water during the dry summer months. *The alteration of river courses and the change in vegetation on the slopes, from endogenous to exotics, which started during the British period and continues even today have had a significant impact on water availability in the lower reaches, the most prominent of which is the Sigur plateau. Checkdams were of help for a few years until the sides were breached or the checkdams themselves were broken by the force of water, which speaks volumes for both design and execution of such projects by various agencies*[24].

Land and Water Use

A Land and Water use study was conducted at the village level in tribal habitations. This revealed several issues: Jenukurumbas are denied access to water supply from adjoining Irula villages; collection of forest produce has been banned by the forest department; farming by tribals is in a poor condition; most of the lands lie fallow year after year; people have migrated to nearby areas in search of daily wage opportunities, while at the same time, outsiders have leased or bought land near tribal habitations and are able to practice agriculture successfully; they use chemical inputs intensively and pollute the land and water; private tourist resorts use a lot of water from borewells and streams resulting in inequitable access to scarce resources.

24 Ibid

Inferences[25]

1. Rainfall and water availability in the plateau – The distinct difference in rainfall in the eastern and western parts of the Sigur plateau determines the availability for use. The western part, which receives one meter, has to contend with higher rates of topsoil erosion. The eastern part, which receives only half a meter of rainfall, has low water availability and increased surface storage must become a critical part of the water management strategy.

2. The groundwater aquifers in the Sigur plateau are small in extent and the expressions of geology at the surface and structural disturbances indicate only a few that offer scope for development. The most promising areas are Siriyur, Bokkapuram, Anaikatti, Chemminatham, Moyar, and Vazhaithottam. It is interesting to note that most of these are already the village settlement areas. The tribal communities must have selected them for reasons largely related to water availability in the form of perennial springs or stream flow.

3. Currently, the irrigation practices are largely surface based and thus wasteful, considering the high evaporation rates involved in flood and sprinkler irrigation.

4. The wasteful use of water is also seen in cultivation of lawns with exotic high-water consumption grass varieties. If lawns are needed at all, then the use of local 'conservative water use' varieties must be encouraged.

5. Soil and moisture conservation practices are extremely poor and will need a good focus if water is to be retained on the cultivated slopes, even though the fields generally have low slope of between 5° to a maximum of 15°.

25 Ibid

6. Wastewater management practices seem to be inappropriate. Sewage and sullage flow into streams from the towns and the situation is exacerbated during the rainy season.

Recommendations[26]

1. Conjunctive use of water – Conjunctive water use, i.e., the use of both surface and groundwater, has to be introduced. The use of surface water in the rainy season till the check dams have water in them will help conserve groundwater till all the surface sources are finished. Groundwater sources must be tapped only during the dry months and the focus must be on conservative use. The tapping of the deep aquifer must be avoided as far as possible, in order to prevent the lowering of the water table, especially in areas where the soil cover is thick. This will enable wildlife to access surface water resources during the summer months, which will also help to reduce human – wildlife conflict.

2. Controlled use of groundwater for irrigation - Since groundwater is and will continue to be scarce in most parts of Sigur, it is recommended that its use is kept low to prevent the depletion of limited groundwater aquifers and its consequences on both wildlife and vegetation.

3. Increasing water use efficiency – There is scope for increased use efficiency in both farming and domestic use of freshwater. All the leakage sources of freshwater such as wasteful surface irrigation (high evaporation loss), etc. need to be identified and the knowledge disseminated among the communities in Sigur.

4. Rainwater harvesting – Rainwater harvesting for both use and storage during the rainy season must be encouraged (and

26 Ibid

probably enforced) for all commercial institutions and encouraged in all private dwellings.

5. Tree planting and management - The planting of endogenous dicots and leguminous trees should be increased, especially along farm contour bunds and high runoff points. Village communities should be encouraged to plant a broad variety of trees as woodlots to meet their fuel wood requirements.

6. Groundwater recharge – The recharge of water through borewells and dug wells must be conducted appropriately to avoid both clogging by fine particles and contamination by polluted water.

7. Repair of check dams – The design of all the check dams built at Siriyur, Bokkapuram, Manavalla and others must be reworked and then rebuilt after considering both retaining strength and holding volume. The design must incorporate mechanisms for the introduction of slats to increase retention and recharge of the phreatic zone during the end of the rainy season. This will increase overall water availability.

8. Greywater recycling – The greywater component of domestic wastewater can be recycled to irrigate plants and trees around homes, thereby reducing the use of freshwater for such purposes.

9. Organic farming and improving moisture holding – In many places the low humus content of soils has a negative impact on their moisture-holding capacity. The increased use and recycling of organic materials including farmyard manure and cow dung should be promoted in the villages to improve the moisture-holding capacity of soils. It is essential to build field bunds and reduce the use of chemicals.

10. Improving drinking and domestic water quality - Simple filtration systems to remove particulate matter and leminscate flow forms at end-use points for the tribal communities should be introduced. This will improve the quality of stored water and make it acceptable for domestic use during the difficult summer months, especially if there are prolonged droughts.

11. Water quality testing – Testing water for both chemical and biological parameters periodically is important and will provide information links to the morbidity and mortality of both people and animals.

12. Hygiene and sanitation – It is important to create awareness about hygiene and sanitation and start working towards the introduction of sanitary toilets (twin pit, etc) to reduce/prevent open defecation and contamination of water sources.

13. Spring development–There is scope for development of the freshwater springs in places like Anaikatty. Proper and separate enclosures for drinking and water collection points for people and animals can be designed and built cost-effectively.

14. Grey water treatment in towns – Towns like Masinagudi also release their wastewater, especially during the rainy season, into the local rivers and streams. The introduction of appropriate designs to separate particulate matter and to increase turbulence will help to improve the water quality before final release

Implementation

Based on the findings and recommendations given above, interventions were implemented in seven tribal habitations - Boothanatham, Semanatham, Kurumbapallam, Vazhaithottam, Chokkanalli, Anaikatti and Siriyur. These covered Irulas, Jenukurumbas, Kasavas, and Kattunaickens. Women from these villages formed the Sigur Seemai Water User Group (WUG) to ensure the sustainable management of water resources. Village-level WUGs were also formed to handle location-specific needs. They were trained to develop a holistic understanding of the Sigur water resources scenario, to test water quality and to undertake repairs of their infrastructure. The WUGs meet every month to collect their user charges from every member as well as to discuss water-related issues. They undertake the repair and maintenance of their water supply systems and liaise with the panchayat officials to leverage their resources for water resource management. However, the habitations are scattered over the plateau making frequent meetings a challenge.

The quality of drinking water sources was tested periodically, and the information shared with the WUG members for appropriate action. Several on-field interventions to improve soil and water management were implemented, including plastic-lined ponds for irrigation, solar pumps in Boothanatham for drinking water supply and irrigation, sprinklers and hose pipes for irrigation, repair and maintenance of existing water infrastructure, trainings on operation and maintenance, set up of drinking water supply distribution, ploughing of fallow lands etc. Later, the Water User Group also operated a retail outlet in Masinagudi to promote forest and farm produce of the tribal communities from across the NBR. This was a source of income for the WUG and helped it build up a corpus to meet future needs.

Drinking water being manually lifted from an open well in summer

Streams and Waste Management

During the initial years of British settlement in the Nilgiris, springs were major sources of water and it was convenient to use them as the primary mechanism for disposing of waste downstream. Sadly, even today streams and rivers, some of which are perennial, are used as sewage drains and are not used as a source of drinking water locally. Water quality tests reveal the presence of coliform across the Nilgiris. Basic chemical tests do not reveal an alarming situation, although the levels of pesticides and fertiliser residues are not known as these require specific tests that are quite expensive. A scenario-building exercise carried out by Keystone in 2012-13 for the Coonoor basin pointed to the possibility of high nitrate loads in the Coonoor river as a result of solid waste, run-off from vegetable farms and tea estates etc. The region has a high inflow of tourists every year which exerts a tremendous pressure on the water availability as well as on waste disposal.

Traditionally the communities believed that spring water was pure and consequently temples were built on springs and they were worshipped. However, our water quality monitoring data from the last year shows that even spring water shows the presence of coliform indicating faecal contamination of groundwater. Well water is by and large understood to be of poorer quality than spring water. In villages that get water from both sources, spring water is used exclusively for drinking and cooking.

The linkage between groundwater and sanitation is not very well understood. Although people do associate open defecation with water pollution, it is understood to be run-off carrying the faecal matter and contaminating the wetlands. The underground route

Coonoor River

through soak pits and infiltration which could contaminate springs as well as wetlands and wells is often ignored. Even in the programmes of the government such as Swachh Bharat Abhiyan, and its previous avatars, the contamination of groundwater through soak pits that allow percolation of faecal matter into the groundwater is not adequately taken into consideration.

In over two decades of work on water resources in the NBR, sanitation has been a factor that is closely linked to water quality. In recent decades, open defecation has been the norm in most of the tribal areas. However, according to the tribal elders this was not always the case. In the olden days, families dug pits in their fields. They placed wooden planks on top to facilitate squatting. These pits were used as toilets. The faeces would be covered with soil and leaves and over time would decompose. When a pit was full it would be covered up and a new pit dug. However, as many tribal villages moved out of forests for a variety of reasons, they lost access to their farms and with increasing wildlife movement close to habitations, they could no longer create and maintain these pits. This resulted in the practice of open defecation which is now being slowly replaced by conventional toilets under various government programmes.

In the Ambikapuram valley where Keystone has been monitoring well levels and taking water quality measurements on a monthly basis, ammonia was found in the water. Ammonia indicates that there is inadequate time for faecal matter to travel underground before mixing with the groundwater. This needs to be better understood through observation across seasons and the mapping of faecal flow directions. However, given that most villages have sewage pipelines that lead to the wetland in the valley where the water sources are also located, and the distance between the habitation and wetland is often less than a kilometre, it is quite likely that contamination of water sources is taking place.

Scenario Building

Keystone wanted a better understanding of the various factors affecting the availability and quality of water, in order to advocate for mainstreaming conservation action in district public policy. While the focus was on Coonoor, a larger area was taken up for the study.

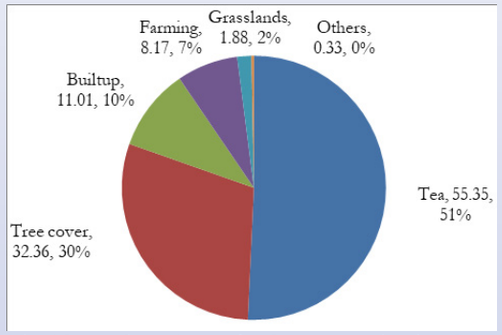


Fig. 30. Land use/cover for Coonoor region in 2012 (Area in Sq. km) derived from Satellite Imagery from Google.

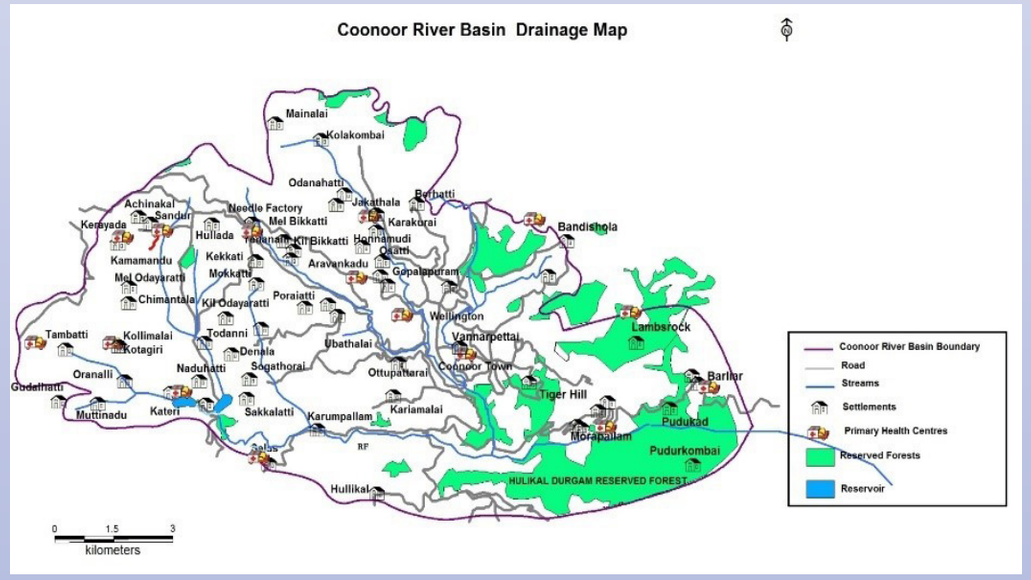


Fig. 31. Drainage map of Coonoor region

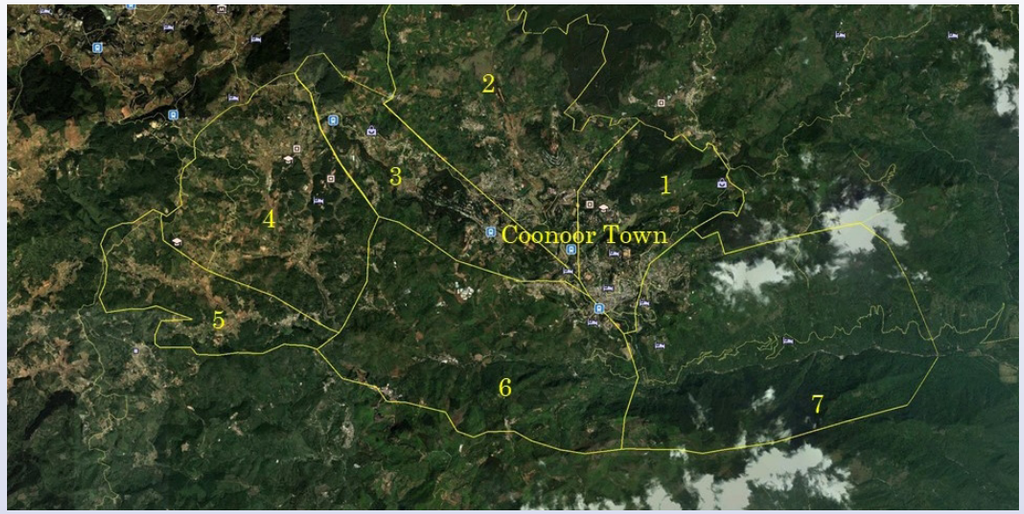


Fig. 32. Sub-regions of Coonoor Region

The area was divided into smaller catchments which had different land use patterns.

Keystone wanted to show examples of what could occur if there was no change in approach. In order to present these alternative "futures", a computer simulation exercise was carried out. This is a computer programme that is designed to simulate what might or what did happen in a situation. Scenarios for a 20-year period were simulated.

Two specific questions were looked at:

- Level of water deficit in the region: To understand whether there is sufficient water available in the region to meet the needs of various sectors.
- Level of nitrates in the stream: To look at the level of chemical and biological pollution in the streams.

In the baseline scenario, the population was assumed to grow at 1.5 % per year and tourist population at 5 % per year. In hindsight, the population growth was over-estimated, and the tourist growth under-estimated. In this case, there was a water deficit in seven out of the 20 years.

Among the sub-regions there was a water deficit in two sub-regions as more area was being farmed.

Nitrates were always more than four times the safe limit for drinking, which is 40 ppm. They were also more than 300 ppm in sub-region 1, which includes Coonoor town, and crossed the 300 ppm mark in a few years in sub-regions with more farming. This shows that if the current trends continue, there will be a major water crisis in the coming years both in terms of quantity and quality. If we add uncertainty due to climate change as well as the issues related to distribution of water into the mix, then the crisis is much more immediate.

Additional scenarios were also simulated which included increasing urbanisation which resulted in increased water deficit, increased organic farming which resulted in significant reduction

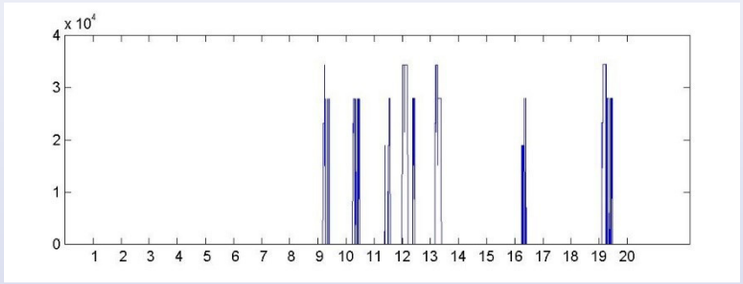


Fig. 33. Water Deficit in the Coonoor region over 20 years (Cu. m. per day)

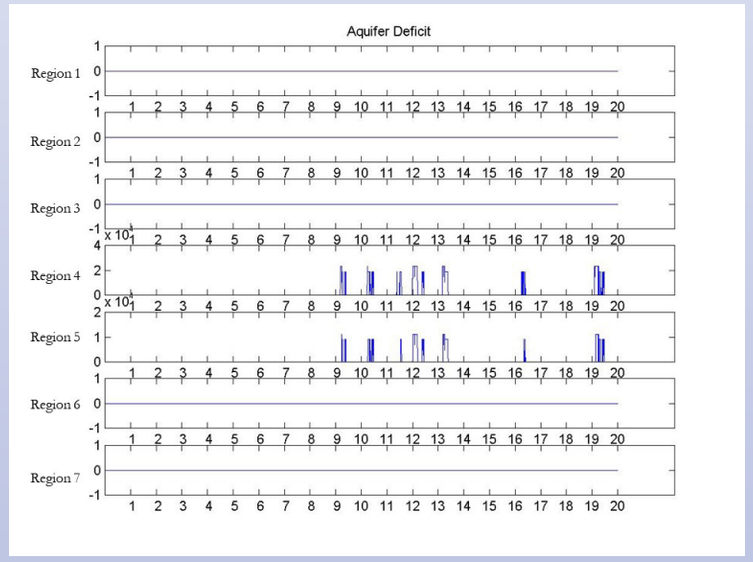


Fig. 34. Water Deficit in sub-regions over 20 years (Cu. m. per day)

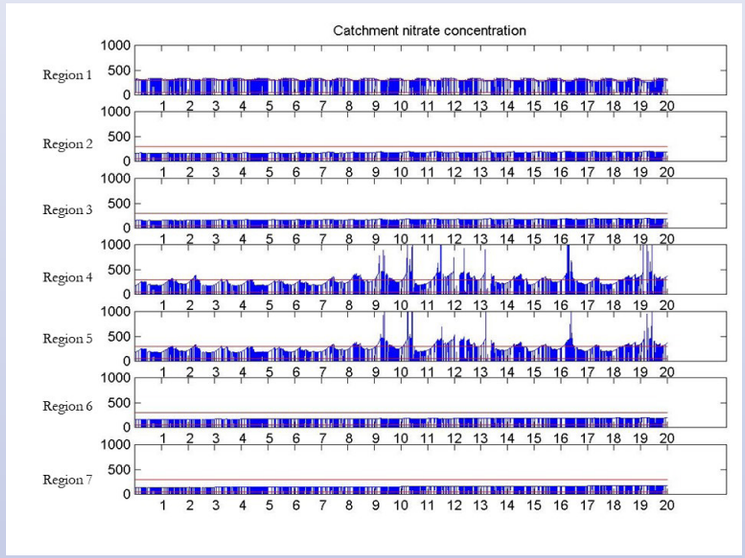


Fig. 35. Nitrate load in the river in sub-regions over 20 years (ppm)

in nitrate levels in streams, reduction in solid waste which again resulted in reduced nitrate levels and conversion of exotic tree species to grasslands which resulted in decreased water deficit.

These simulations showed the importance of land use pattern in the quantity and quality of water available in the region. They also predicted a high level of nitrates in the stream water, which indicates that the problem of waste management in the region is being pushed downstream to people who depend on the stream water for agriculture, drinking etc.

Locally, the villages do not depend directly on streams for their water supply. The pollution is being sent downstream out of the Nilgiris where the communities living next to the river have to deal with the consequences.

Thus, it was possible to demonstrate the cumulative impact of various sectors on the water resource situation in the region and generate a consensus on the need to act on it. Keystone was able to show what happens to the water due to the combined effects of different 'sectors' – domestic, tourism, plantation, sanitation, agriculture etc., which normally operate independently of each other.

These scenarios were presented to a group of stakeholders in the region and to the District Collector of the Nilgiris and various line departments. Laypersons too were able to quickly grasp the significant messages regarding land use and waste management.

With bottled water and water tankers becoming commonplace in summer, there is already a market for water in the region. In order to intervene in this situation, Keystone decided to try an innovative approach. During 2013-15, along with its other services, it examined the possibility of using a Payment for Ecosystem Services (PES) approach to formulate a possible solution to the water crisis.

A river in full flow

Payment for Ecosystem Services (PES)

Coonoor is an urban centre that is a popular tourist destination in the Nilgiris. It has up to 3.5 million tourists passing through in a year, compared to a local population of approximately 45,000 people. Tea and tourism are the big economic drivers in this area.

The Coonoor municipality is responsible for providing safe and sufficient water for drinking and other domestic and commercial use to all the inhabitants as well as institutions in the town. The total storage capacity is estimated to be 18.44 lakh Litres Per Day. According to the Municipality, it is providing 90 Litres Per Day (LPD) per capita to the local population when water is available in plenty, and around 43 LPD once in five days during the summer.

This supply is directly dependent on the state of the water resources that Coonoor town is tapping. The municipal water sources for Coonoor town are:

1. Ralliah Dam
2. Gymkhana
3. Guerency
4. Highfield
5. Bellattimattam
6. Bandhumi Dam
7. Karadipallam
8. Upputhotti
9. Attadi
10. Brooklands
11. Old Forest
12. Adaar
13. Ambikapuram
14. Nariyani

The sources include two dams, Ralliah which has a height of 43' 6" and Bandhumi which has a height of 15'. The others tap streams that carry runoff water during the rains and base flows during the non-rainy period. The origins of these flows are in springs within the catchment areas of these sources. The water is tapped by building retaining structures and pumping the water or by digging open wells that are used to pump water to storage structures.

Ralliah Dam in Coonoor

There are four main water sources that provide nearly 75 % of the water supply to the town. Most of the Ralliah dam's catchment is under the control of the Forest Department and is covered with plantations of exotic tree species. Given that the municipality is planning to divert water to the dam from upstream reservoirs, there will soon be little relationship between the catchment characteristics and the amount of water impounded in the dam.

An automated rain gauge was set up to record every rainfall event, and Keystone has been sharing this data with the municipality. The decision was taken to focus on the two other main catchments of Coonoor, namely Guerency and Gymkhana, and the catchment of these two areas was mapped with the help of satellite imagery from Google Earth.

Unlike Palampur in Himachal Pradesh, the site of the first PES arrangement in India, where the springshed of the main water source of Palampur town was under the jurisdiction of a Village Forest Development Council (VFDC), the catchment area of Coonoor's main water sources has a complex geohydrology, multiple aquifers, highly privatised land use and villages that are not actively involved in natural resource management. The opportunity cost of land is very high, given that it is a tourist destination and a very popular haven for those looking for second homes. Thus, the catchment areas, being mostly under private ownership are always threatened by the possibility of being sold off piecemeal for construction of residences or guest houses. The mining of groundwater is also increasing with the potential for future conflicts between village panchayats and the municipality. For example, the source of water for the village of Bellattimattam is near the Nariyani spring in the Guerency catchment area. There is an old spring box that taps the spring water and supplies water to the village through gravity. In 2015-16 a new well was dug by the Coonoor municipality to supply water to the town. Keystone has initiated monitoring of the spring flow to assess the impact of the pumping by the Municipality on the spring discharge on which Bellattimattam is dependant.

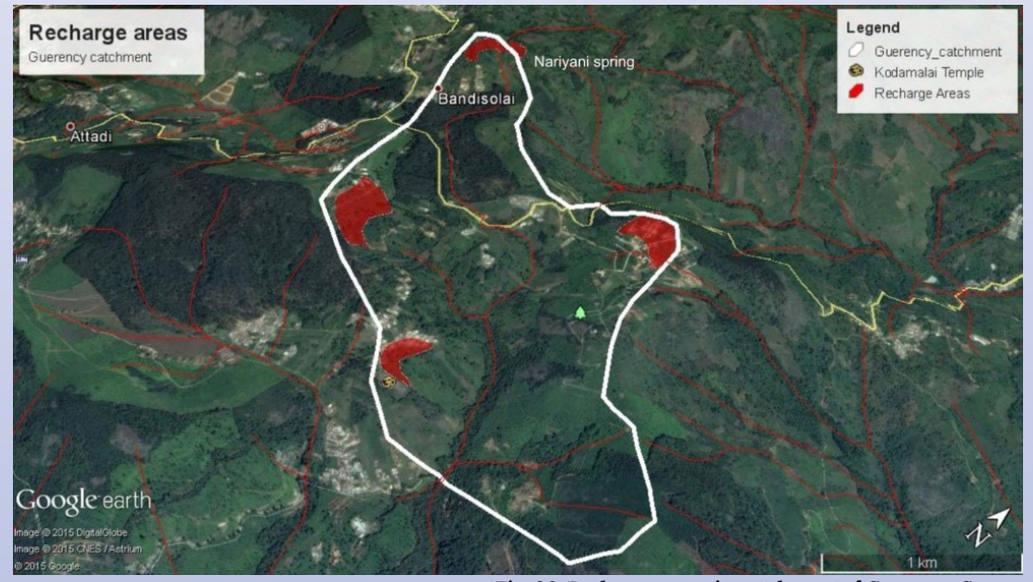


Fig. 36. Recharge areas in catchment of Guerency Source

A PES arrangement in such a complex situation cannot just involve the municipality as a buyer and the village panchayat or private landowners as sellers. It is a collective resource on which the villages, private estates and the town are dependent. There is thus a need for the state to invest in improving the water recharge and quality for all the parties concerned by incentivising favourable land use.

This project has laid the ground for an exploration of the landscape of water resource management in the Coonoor region. There are possible alternatives that have been developed. Keystone has worked together with scholars from Cornell University to explore the range of PES arrangements tried out worldwide to provide recommendations for the Coonoor region. In order to find viable alternatives, a multi-stakeholder dialogue process is needed. The socio-ecological system indicates that many influencing factors lie outside the focal system. These factors include state level policy makers, heads of line departments as well

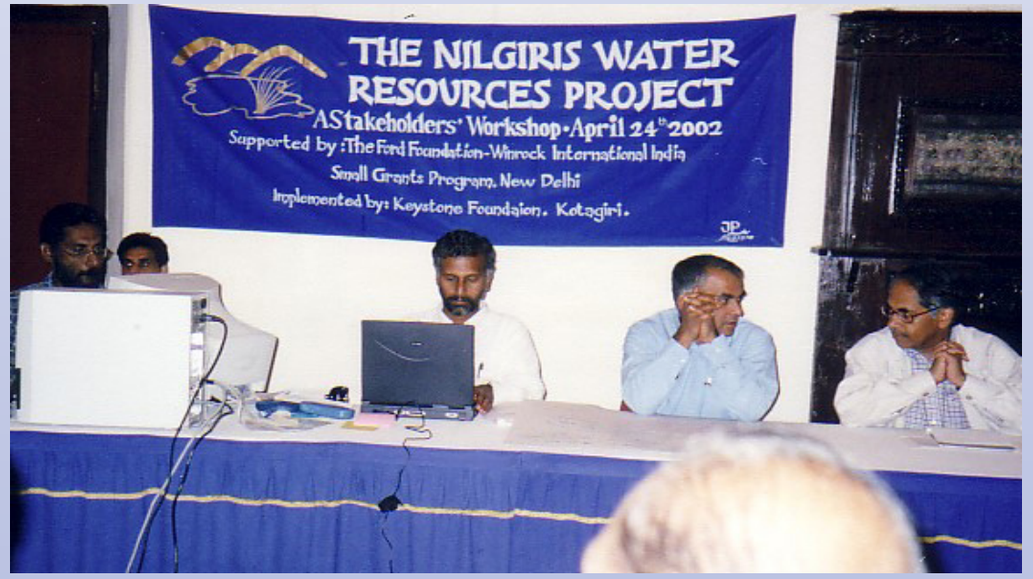
as the district administration, who can leverage various on-going programmes that influence land use. They can steer them in a way that incentivises land use favourable to improved water quantity and quality for all the stakeholders in the system.

The data and knowledge gathered over the years of Keystone's work has been made available on a website (https://nilgiriswaterportal.in) in the public domain to spur action by civil society and other actors. Looking at this body of work, citizens' groups in Coonoor and Ooty have reached out to Keystone to undertake interventions to conserve these water resources. Keystone is partnering with these groups to influence local government policy and to promote volunteer efforts.

Nariyani Spring

RECOMMENDATIONS

Looking back at nearly 25 years of working in this region, one cannot but remember the quote 'The more things change, the more they stay the same'. There are superficially many developments in the Nilgiris, but the underlying pattern of utter disregard for the environment in the pursuit of growth has not changed. If anything, drivers such as tourism, urbanisation, exploitation of natural resources etc. seem to have grown significantly. In this context, it is worthwhile recollecting the collective resolution taken up in the landmark stakeholder meeting in Ooty in 2002. The work shared earlier may be seen in the light of these recommendations as Keystone's commitment to upholding the collective dreams of a cross-section of society.



Stakeholder Workshop

The Nilgiris Declaration on Hill Water Resources Management

Recommendations of the Consultative Stakeholder Group

Udhagamandalam, The Nilgiris, April 24, 2002

Background

Water resources in the hill district of the Nilgiris in Tamil Nadu, play a crucial role not only in ensuring access to water for drinking and other uses to the rural and urban communities in the district, but also serves as the upstream source to four river basins serving the states of Tamil Nadu, Karnataka and Kerala. The water resources of the district are used for power generation and account for more than a third of total hydropower generated in Tamil Nadu. Natural forests (sholas) and products therefrom, tea and coffee plantations, agricultural activities, tourism, and trade and commerce constitute the economic edifice and provide livelihoods to residents of the district. The district is located over an elevation range of 1,000-2,636 m above sea level, comprising hilly peaks, plateau and lower plateau regions. Most of the settlements are located in the latter two elevation ranges.

Nilgiris, located in the north-western part of Tamil Nadu state and spread over an area of 2,549 sq km, supports a population of 0.76 million (Census of India, 2001). About 41 percent of the population resides in the 900 rural habitations of the district, whereas the four urban centres of Udhagamandalam, Kotagiri, Coonoor and Gudalur, comprise the balance. The district is home to a number of indigenous and tribal communities including the Todas, Kotas, Irulas, Kurumbas, Mullu Kurumbas, Betta Kurumbas, Kasavas, Kattunaickens, Paniyas, Chettis and other tribes (a tribal population of about 30,000 persons). These tribal communities, apart from other communities who are residents of the Nilgiris, have settled in specific altitudes and are dependent upon livelihoods characteristic of these regional resources, apart from their own historical

and cultural traditions, including those pertaining to management of water.

Recognizing the criticality of water to the district in a situation increasingly characterised by recurrent shortages and competition between uses, a study of Nilgiris water resources was undertaken in the district over 2001-2002. The salient findings from this study were discussed by a consultative stakeholder group comprising administrators, researchers, practitioners, NGOs, representatives of different regions, communities and occupations, and other stakeholders, on April 24, 2002, in Udhagamandalam.

Issues in Nilgiris Water Resources Management

This Consultative Group has taken special note of the following Study findings:

The Nilgiris is an upstream catchment district and the bulk of its water resources are dedicated to power generation for the state. The interests of the Nilgiris district vis-a-vis those of other districts and the state, will come in focus with increasing demands. Further, water policy and programmes in the state are not fully suitable to this hilly terrain and alternate approaches are needed that are based on local experience and best practice in other hilly regions.

The district experiences six months of dry period, is witnessing changes in the days and pattern of rainfall, has aquifers with limited ability to hold water for long periods, and signs of water stress in particular rural and urban locations are incipient.

Access to water resources seems to be determined by the location of settlements. With growth of settlements, a mismatch has emerged between locations of settlements (both rural and urban), and ready availability of reliable water sources nearby.

The district depends on a variety of sources including springs (feeding about 30 percent of settlements), wells (28 percent), streams (24 percent), checkdams (6 percent), and others (rivers, tanks, borewells, etc.). Amongst user communities, there is a high dependence on and preference for water from springs, streams and wells. These water sources need to be studied and conserved in a systematic manner. Further, there are a number of inter-linkages between the former two categories and other resource regimes (grasslands, sholas, plantations, etc.) that need further understanding for improved water management.

Overall, water resources are said to be abundant in the district but about a third of the sources are seasonal, more than 80 percent rural settlements have less than 40 LPCD (Litres Per Capita per Day) of water available, and shortages are common in urban locations. These point to the urgency of studies and concerted action in the areas of water resources development, and judicious use and management of water resources and related resource regimes.

Traditional practices in water management have thrived in the district and provide an opportunity to learn from, for design of management mechanisms for the present and the future. There is a need for revival of traditional water management systems that are fast falling out of use.

Management of water resources and related resource regimes is the business of many stakeholders in the district and therefore, consultative processes

of planning, decision-making and implementation are crucial for successful outcomes for the district.

Recommendations

The Consultative group has discussed the above and related issues in detail and now recommends:

Water Resources

- The special role of Nilgiris in water and power generation must be highlighted in Tamil Nadu.

- Sholas and grasslands must be protected as they have the greatest impact on water yields.

- Swamps and grasslands planted with exotics over the last few decades, can still be recovered if these are supplemented with measures of managing land-cover to increase recharge and retention. Further planting of exotics must not take place in the Nilgiris.

- Supply of firewood to villagers on reasonable terms and with subsidies if required, must be vastly increased so as to relieve the pressure on sholas. The proposal to allow people to use firewood for domestic use from existing exotic plantations, may also be considered.

- An advisory body to coordinate the work of NGOs, departments, research institutions, and elected people's representatives, should be formed to formulate a comprehensive Land and Water Use and Management Policy. This group would act also as a pressure group for improved management of Nilgiris water resources.

- Springs, streams, other water sources and related resource regimes need to be studied further to inform policy and operational management strategies for different stakeholders.

Water Distribution and Management

- In keeping with the spirit of the National Water Policy, domestic water supply needs must have the first charge on water resources. Due recognition needs to be accorded to water for agriculture, plantations and other commercial purposes. However, wherever there is a situation of conflict between uses, domestic use needs to be given priority and other uses regulated appropriately.

- At present, water resources of the Nilgiris are applied to production of power and thereafter made available for farmers in plains regions. Water requirement of the agriculturists of Nilgiris needs to be accorded importance and appropriate policy measures taken to ensure equitable rights over water resources across plains and hilly regions.

- The development of water resources has come under increasing strain lately owing to demands for more water. This situation needs to be corrected by careful planning of storage for dedicated uses with due regard to environmental and social considerations.

- Operations and maintenance of water conveyance and distribution systems, both in urban and rural areas, need to be undertaken efficiently. This should lead to loss reduction and benefits to domestic and other users.

- Proper planning for wastewater treatment and disposal are also necessary to reduce pollution in water bodies as also to make best possible use of available water.

- Formation of Water Users Groups (WUGs) and people's associations is necessary to ensure equity in the distribution of water resources.

- Panchayats and municipal

bodies are the legitimate bodies to ensure equitable distribution of water resources and in case of conflict, the district administration should intervene, especially to protect the rights and interests of the poor and vulnerable groups in the Nilgiris.

• Concerted efforts need to be made to provide a larger role to local water users' groups and PRIs, in the design, construction and maintenance of water supply and sanitation systems. Appropriate capacities and resources will need to be devolved for the local bodies to undertake these functions efficiently. Many, if not most of the water systems are simple and perhaps well within the capacity of local bodies and user groups to construct and manage. A beginning needs to be made with these simple systems.

Communities and Water Management Systems

• There exists a gap between demand and supply of water in many locations. The measures and innovations that need further investigation and application, include:

Preservation of swamp areas

Minimizing of wastage and prevention of contamination of sources

Recycling

Awareness generation

Potential of rainwater harvesting to minimize pressure on existing water supply systems where appropriate

Equitable water usage – guidelines required in the long term

Involving communities in planning specifically for identification of sources

Improving coordination between implementing bodies (e.g. Forest Department, Tamil Nadu Water Supply and Drainage Board, Tamil Nadu Electricity Board, Panchayati Raj Institutions)

Sensitising politicians

Planning for expansion of settlements as well as for resettlement

• The roles and responsibilities between state institutions and community institutions is an area for continuous review and improvement based on experience and learning from best practice elsewhere in hill systems. While further studies and consultations are required to experiment with changes in institutional mandates and division of roles, the following measures need to be considered in the short run:

Water planning at local levels with

- participation in decision making,

- contributions from users

Promoting institutions for water management in rural and urban areas

Users having a major role in designing projects

Identifying and protecting water sources even under private ownership

Documentation and study of traditional water management systems to learn for the future

Sustainability Issues

• In the Nilgiris, rainwater harvesting needs to be attempted, but with due consideration to local conditions (rainfall, topography, social and environmental parameters). Water-harvesting structures could be encouraged for agriculture

• There are several existing government departments that are involved in water management (Tamil Nadu Water Supply and Drainage Board, Forest Department, Public Works Department, TN Electricity Board, TN Pollution Control Board, Panchayati Raj Institutions, Health Department etc.). Instead of creating another specialised institution, coordination amongst these agencies should be improved to ensure desirable outcomes in integrated water resources management in the Nilgiris

• Awareness amongst stakeholders, within the district as well as at the level of the state, must be increased

• In the long term, responsibilities to plan, design, operate and manage water systems must become the business of local communities and their representatives

• Continued dependence on external agencies will not be a sustainable solution and the hand-over of systems must be started gradually

• Pollution of water resources urgently needs to be controlled and reduced by:

Controlling and eliminating encroachments in the catchment areas

Treating rural and urban effluents in a cost-effective manner and ensuring their recycling and safe disposal

Promoting organic farming

Identifying pollution zones from establishments and industries

Establishing a village/user level water quality monitoring mechanism and generating awareness on a regular basis

Establishing a systematic water surveillance and quality monitoring system across the district

• Immediate and recurrent drinking water shortages need to be tackled by:

Rejuvenating and improving water storage systems

Reviving traditional systems

Reviving defunct systems

Protecting water sources – preventing encroachment

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While the situation analysis and the recommendations are largely valid even today, Keystone has come a long way since then in terms of deepening its work on water, biodiversity conservation and sanitation. For instance, the work in Sigur plateau, one of the most water-scarce areas in the district, empowered women-centred Water User Groups to take charge of their own water resource management. Though this could not break the dependence on the panchayat to provide infrastructure support, it helped these marginalised communities to have a stronger voice when negotiating with the non-tribal dominated panchayats. Keystone believes that it is thus more important than ever to strengthen communities, especially women, as a part of its interventions.

Keystone's efforts at ecological restoration are now targeted at wetlands, their catchments, springs and springsheds. Forest or biodiversity conservation is important, but in these times when water is capturing everyone's imagination, it is useful to see the synergies between the two. Thus, ecological restoration is one of the key strategies to improve the water situation in the region.

Old notions of poramboke land and waste land that devalue invaluable natural resources need to be shunned in favour of a recognition and respect for all natural resources. The first step in this is to inventory all the common water and land resources in each village or town or locality. If we don't know what we have, how will we know what we are losing and what we have gained?

There is also a need to develop aquifer-based thinking, considering the overwhelming dependence on groundwater for all our needs.

Water resources are dynamic and seem to be changing all the time, be they spring flows, rainfall patterns, stream flows etc. However, some of these have cycles that are not immediately apparent, whereas others have been exhibiting uncertainty over a long period of time. For instance, the analysis of nearly 80 years of monthly rainfall data from UPASI, Coonoor revealed that the rainfall pattern has no discernible rhythm and has always been dominated by uncertainty. Therefore, all planning needs to take into account change and variability. This requires periodic monitoring of water and land resources.

Managing water resources – particularly groundwater – sustainably, requires, among other things, access to good quality data. These are not available from any secondary sources. Therefore, one has to generate good quality primary data oneself. In this age of Information Technology, technologies like GIS, remote sensing, Internet of Things etc. that can address practical problems in a cost-effective way should be leveraged. This data must be shared in the public domain to maximise the utility of the data collection effort. This would allow the data to be leveraged into a larger database to make a greater impact.

At the same time, to make the efforts sustainable, the cultural connect that the local communities have should be leveraged, so that participatory water resource management can be embedded in a strong cultural fabric.

It is imperative that conjunctive water use – the use of both surface and groundwater - be introduced. The use of surface water in the rainy season and till the storage structures have water in them will provide for the conservation of groundwater till all surface sources are finished. Groundwater must be used conservatively. As far as possible, tapping of the deep aquifer must be avoided so as to prevent the lowering of the water table, especially in areas where the soil cover is thick. This will also help wildlife to access surface water resources during the summer months, thus reducing human – wildlife conflict.

The use of streams as sewage lines must be stopped. It is a criminal waste to render perennial water sources unfit for any use and then expending resources in getting water from long distances. Waste management and sanitation are key areas to improve water management.

Invasive species that are proliferating in the Nilgiris are detrimental to the availability of water in its catchments and aquifers. Removal of invasive species and replacing them with native species suitable to the location should be a priority.

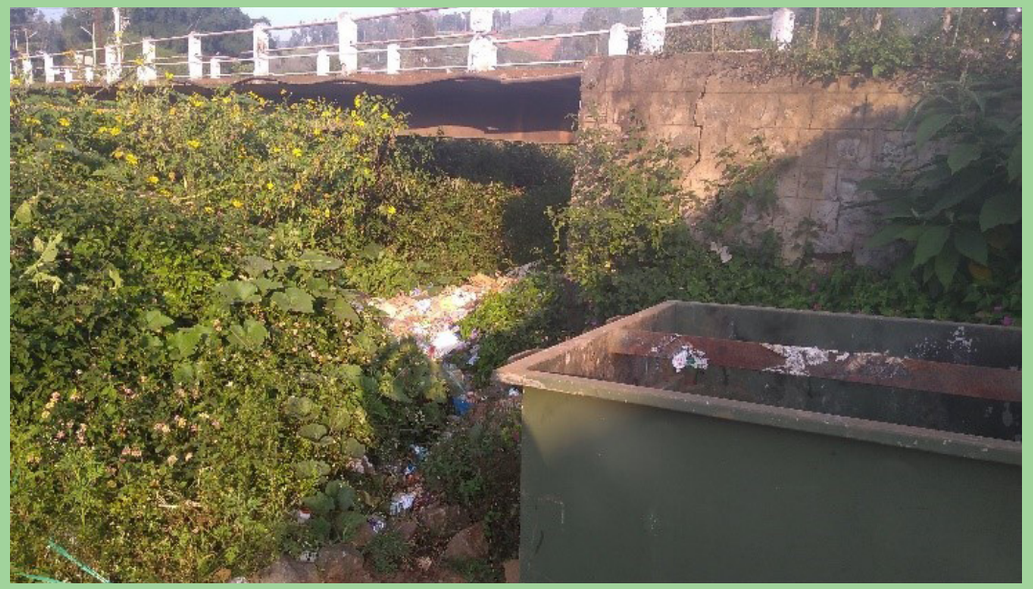
Community members removing invasive plants

WAY FORWARD

In its 25th year, Keystone won the prestigious HCL Grant in the Environment Category. The five-year grant enables Keystone to converge many of the above-mentioned aspects such as water conservation, ecological restoration, wildlife conservation, culture, organic farming, water quality and waste management, collective action etc., in four sites. Keystone is identifying key water resources in each landscape along with the communities there, with a view to meet the needs of both the people and the environment. Partnership with local citizens' groups and the district administration is a key to the success of this initiative. In the true spirit of eco-development, Keystone is facilitating location-specific packages of interventions that are inter-disciplinary and address water conservation in a holistic manner.

Wildlife is viewed as an equal stakeholder rather than merely a source of conflict. The catchment areas are being mapped and ecological restoration is being used as a key strategy to revitalise these landscapes. The invasive species and solid waste that clog up these areas are being removed and native plant species from Keystone's nursery and other sources are being re-introduced. These landscapes are the source of streams on which the downstream communities depend. Therefore, efforts are being made to undertake ecological restoration of stream banks to restore water flows and re-enable natural purification of water that is being polluted upstream. As a result of these interventions, water quality is being tested at locations upstream and downstream every year to track the changes in water quality. Here are the interventions at Kookaltkorai near Kotagiri in pictures.

Stream at Kookalthorai before intervention



Waste dumped in the open while dustbins lie unused

Sanitary workers from the area participating in the cleanup

Community members and volunteers cleaning the Kookalthorai stream

Earth moving machine in operation

Loads of plastic and other waste being removed

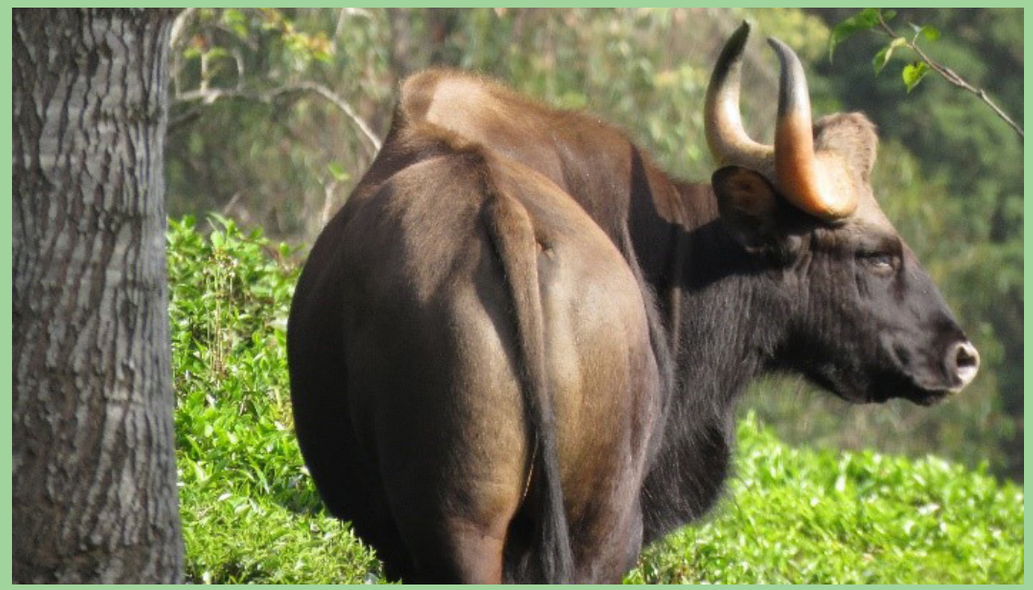
Stream and streambank cleaned of plastics and invasives

Planting native species to restore the ecosystem

Catchment of the stream has intensive chemical input-based farming

A field with organic compost ready for farming

Training farmers on organic input preparation



Wildlife trying to find its place in the landscape

Towards a water secure future for the landscape for people and the environment

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